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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

FIELD AND DEPOT MAINTENANCE
RADIO TRANSMITTER MODULATOR MD-203/GR

HEADQUARTERS, DEPARTMENT OF THE ARMY

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RADIO TRANSMITTER MODULATOR MD–203/GR

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CHAPTER 1

THEORY

1. Scope

a. This manual covers field and depot maintenance for Radio Transmitter Modulator MD–203/GR. It includes instructions appropriate to third, fourth, and fifth echelons for trouble shooting, testing, alining, and repairing the equipment, replacing maintenance parts, and repairing specified maintenance parts. It also lists tools, materials, and test equipment for third, fourth, and fifth echelon maintenance. Detailed functions of the equipment are covered in the theory section.

b. The complete technical manual for this equipment includes TM 11–5820–205–10, TM 11–5820–205–20, TM 11–5820–205–20P, and TM 11–5820–205–35P.

c. Forward comments concerning this manual to the Commanding Officer, U. S. Army Signal Publications Agency, Fort Monmouth, N. J.

Note. For applicable forms and records, see paragraph 2, TM 11–5820–205–10.

2. System Application

Radio Transmitter Modulator MD–203/GR is a link in a complete radio teletypewriter communications system.

a. The teletypewriter signals developed in Teletypewriter TT–98B/FG (fig. 1) are supplied through Junction Box J–668/GR to Radio Transmitter Modulator MD–203/GR. The modulator is connected directly into the exciter section of Radio Transmitter T–195/GRC–19 to produce shifts in the continuous-wave (cw) signal. The signal generated by the transmitter oscillator is coupled through the modulator to the remaining transmitter stages. The frequency shifts correspond to teletypewriter impulses. The teletypewriter signals are radiated by the transmitter antenna in the form of frequency-shift keyed (fsk) radio signals. The total frequency shift at the output of the transmitter is 850 cycles per second (cps) on any transmitter frequency. The frequency shifts 850 cps lower for a teletypewriter mark signal and back to the original transmitter frequency for a teletypewriter space signal. With no characters being transmitted, the radio-frequency (RF) output rests at the higher (mark signal) of the two frequencies.

b. The frequency-shift radio signals are intercepted by the receiver antenna and applied to Radio Receiver R–392/URR. The 455-kilocycle (kc) output receptacle of the receiver is connected directly to Frequency Shift Converter CV–278/GR. Frequency Shift Converter CV–278/GR converts the 455-kc receiver output to direct-current (dc) pulses suitable for operating the teletypewriter and reperforator printers. Teletypewriter TT–98B/FG causes a relay in Junction Box J–668/GR to make and break.

3. Block Diagram

Radio Transmitter Modulator MD–203/GR is capable of converting continuous-wave signals into frequency-shift signals in the range of 1.5 to 3 megacycles (mc). The signal path is shown in the block diagram (fig. 2) and is discussed in *a* through *h* below. For complete circuit details, refer to the overall schematic diagram (fig. 35).

a. The signal output of the transmitter exciter section is applied through MO INPUT receptacle J101 to modulator dual input filter FL101. The input filter divides the steady cw signal into two paths. The path utilized in the filter is determined by the position of the MCS BAND SELECTOR switch S101. The two signal paths of the filter are composed of different filter networks to filter out harmonics of the signal frequency before application to the first mixer. The correct position of the MCS BAND SELECTOR switch completes the circuit for

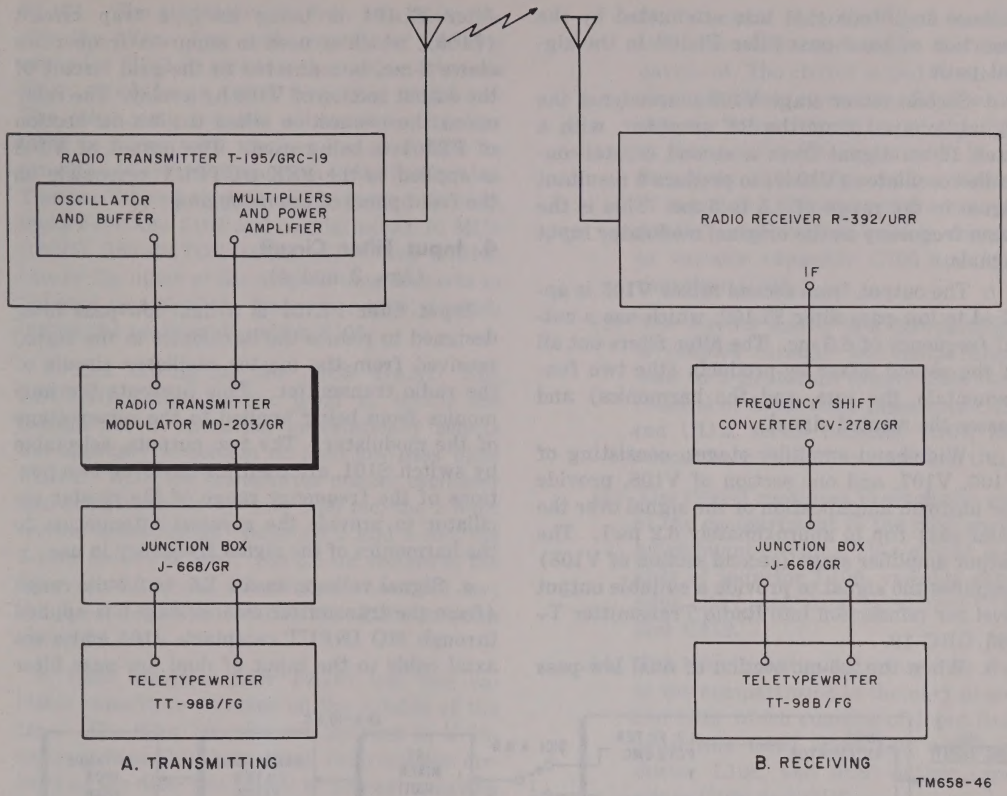


Figure 1. Radio teletypewriter communications system, simplified diagram.

the filter network that will provide the best filtering for that part of the frequency range. The FC-2.6-mc section passes frequencies from 1.5 to 2.25 mc and rejects frequencies above 2.6 mc. The FC-3.4-section passes frequencies from 2.0 to 3.0 mc and rejects frequencies above 3.4 mc.

b. The output of filter FL101 is coupled to the input of first mixer stage V101. The mixer stage heterodynes the input signal with the output of 12-mc first oscillator V102. The plate circuit of the mixer is tuned to the sum frequency in the 13.5- to 15-mc range. The heterodyning signal, produced by the first oscillator, provides instantaneous frequency shifts.

c. The frequency shift keyer provides instantaneous frequency shifts in the heterodyne frequency. The frequency-shift circuit functions as a frequency-shift keyer to provide four different amounts of frequency shift in the first oscillator frequency. The desired amount of frequency shift is selected by a section of the MCS BAND SELECTOR switch, which selects an appropriate capacitance value for the frequency shift. When the external keying circuit is closed, the frequency output of the modulator is the same as the frequency of the transmitter master oscillator.

d. The output of the mixer stage is applied to band-pass filter FL103, which filters out all of the unwanted signals (the two fundamentals, the difference, and the harmonics) and allows only the sum of the two mixing frequencies to pass on to the following stage. The frequency response of this filter is from 13.5 to 15 mc. The RF amplifier stage serves to restore the signal

voltage amplitude that was attenuated by the insertion of band-pass filter FL103 in the signal path.

e. Second mixer stage V105 heterodynes the signal received from the RF amplifier, with a fixed 12-mc signal from a second crystal-controlled oscillator (V104), to produce a resultant signal in the range of 1.5 to 3 mc. This is the same frequency as the original modulator input signals.

f. The output from second mixer V105 is applied to low-pass filter FL102, which has a cutoff frequency of 6.5 mc. The filter filters out all of the second mixer by-products (the two fundamentals, the sum, and the harmonics) and passes the wanted signal.

g. Wide-band amplifier stages, consisting of V106, V107, and one section of V108, provide for uniform amplification of the signal over the band pass (up to approximately 3.2 mc). The output amplifier stage (second section of V108) amplifies the signal to provide a suitable output level for reinsertion into Radio Transmitter T–195/GRC–19.

h. When the 2.6-mc section of dual low-pass filter FL101 is being used, a trap circuit (Z105), which is used to suppress frequencies above 3-mc, is connected to the grid circuit of the output section of V108 by a relay. The relay opens the connection when the 3.4-mc section of FL101 is being used. The output of V108 is applied to the FSK OUTPUT receptacle on the front panel of the modulator.

4. Input Filter Circuit

(figs. 3 and 4)

Input filter FL101 is a dual low-pass filter designed to reduce the harmonics in the signal received from the master oscillator circuit of the radio transmitter. This prevents the harmonics from being applied to the mixer stage of the modulator. The two outputs, selectable by switch S101, are used for covering two portions of the frequency range of the master oscillator to provide the greatest attenuation to the harmonics of the signal frequency in use.

a. Signal voltage, in the 1.5- to 3.0-mc range (from the transmitter exciter stage) is applied through MO INPUT receptacle J101 and a coaxial cable to the input of dual low-pass filter

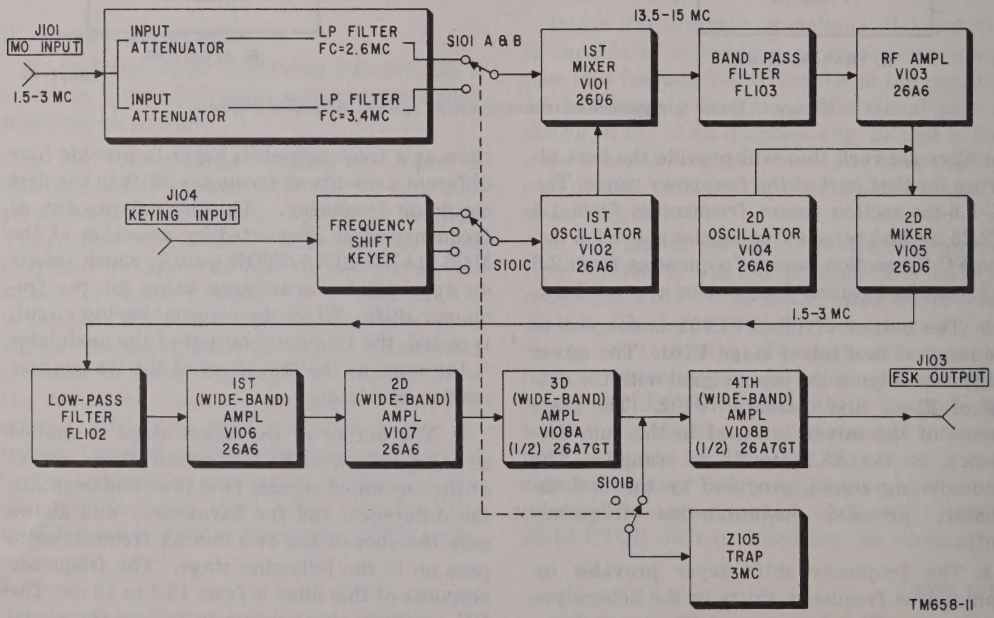


Figure 2. Radio Transmitter Modulator MD–203/GR, block diagram.

FL101. The signal divides into two paths inside the filter. One path consists of variable capacitor C102 in series with another low-pass filter, which has a cutoff frequency of 3.4 mc. The other path consists of variable capacitor C101 in series with another low-pass filter to provide additional attenuation to the harmonics. The two filtered outputs are connected through jacks J106 and J107 and coaxial cables to MCS BAND SELECTOR switch S101 and S101B. One or the other of the outputs then connects to the grid circuit of the first mixer tube, depending on the position of switch S101.

b. The setting of the MCS BAND SELECTOR switch to the band in which the transmitter is operating automatically selects the appropriate section of dual low-pass filter FL101. With the transmitter master oscillator operating between 1.5 and 2.25 mc, the 2.6-mc section is employed. Between 2 and 3 mc, the 3.4-mc section is used. The 2.6-mc section of the filter attenuates all frequencies above 2.6 mc; the 3.4-mc section attenuates all frequencies above 3.4 mc.

c. Dual low-pass filter FL101 has two variable capacitors mounted on the outside of the case. The filter circuits are inclosed in a 10-compartment shield in which the resonant circuits of the filter are placed to prevent coupling between them. The case is sealed by the cover plate to keep out dust and moisture. Variable capacitors C101 and C102 and resistor R101 are mounted on the outside of the case on a separate shield plate. The resonant circuits in the filter are connected in cascade.

d. The input signal is traced from MO INPUT receptacle J101 through coaxial cable W101 to INPUT receptacle J105 of the filter. Resistor R101 (fig. 4) is connected between INPUT receptacle J105 and ground to establish an input impedance of 560 ohms at this point. The circuit divides at this point. One branch consists of variable capacitor C102 and the 2.6-mc filter network. The other branch is made up of variable capacitor C101 and the 3.4-mc network.

(1) The output terminal of C102 connects through the wall of the case to the first resonant circuit of the 2.6-mc filter network located inside the compartment. The circuit is tied to ground through matching resistor R103 which sets the input impedance of the filter at this point. The remainder of the circuit in this compartment consists of inductor L102, connected across the parallel combination which consists of variable capacitor C105 and fixed capacitor C106.

(2) The circuit inside this compartment is coupled through the compartment wall to a pi-section filter. This filter consists of input fixed capacitors C111 and C112, series inductor L104, and output fixed capacitors C112 and C113.

(3) The circuit continues through the wall of the compartment to the next parallel-resonant circuit. This circuit consists of inductor L106, variable capacitor C117, and fixed capacitors C118 and C119.

(4) The circuit continues through the wall of the compartment to the next pi-section filter which consists of input fixed capacitors C124 and C125, series inductor L108, and fixed output capacitors C126 and C127.

(5) The circuit continues through the wall of the compartment to the last parallel-resonant circuit consisting of inductor L110, variable capacitor C130, and fixed capacitor C131, and to OUTPUT receptacle J107 and terminating resistor R105. Resistor R105 sets the output impedance of the 2.6-mc filter. OUTPUT receptacle J107 is connected by coaxial cable W105 to receptacle J109 on the oscillator-mixer chassis (fig. 3). From J109, the circuit is traced through MCS BAND SELECTOR switch S101A (front).

(6) Capacitor C101 is connected between jack J105 and resistor R102 and inductor L101. The theory of operation is the same as for the section described in (1) through (5) above.

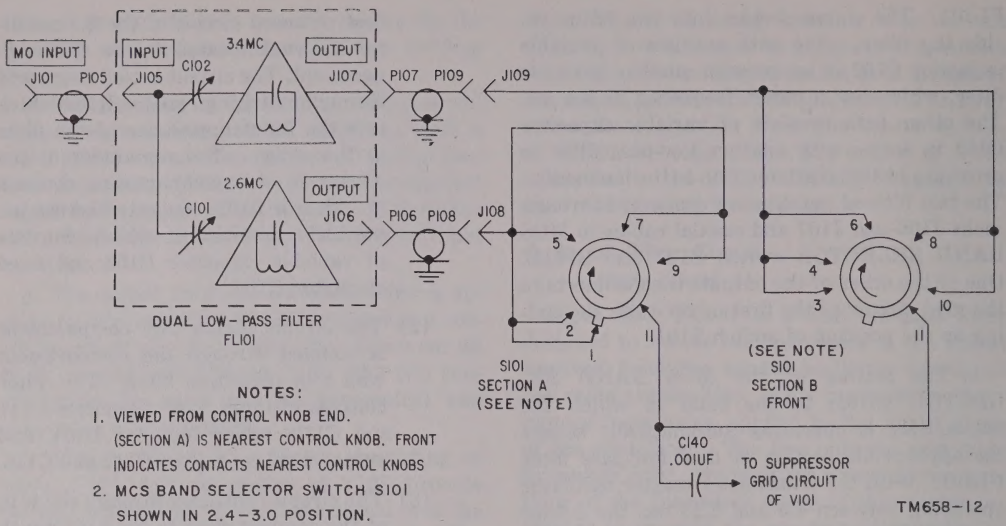


Figure 3. Dual low-pass input filter, FL101, functional diagram.

5. First Mixer V101

The first mixer stage (fig. 5) uses a miniature type 26D6 tube. The signals from the output of dual low-pass filter FL101 are applied to the signal grid (pin 7). The frequency-shift signal output of the first crystal-controlled oscillator is applied to the injector grid (pin 1). The two signals are heterodyned in the mixer stage to produce a frequency-shift signal between 13.5 and 15 mc in the plate circuit of the mixer stage. This frequency is the sum of the two input signals to the mixer stage.

a. The signal is coupled from the MCS BAND SELECTOR switch to the signal grid (pin 7) of the first mixer through coupling capacitor C140. The signal grid is connected to ground through grid return resistor R106. Resistor R107 and capacitor C141 make up the cathode biasing network. The screen grid (pin 6) and plate (pin 5) receive operating potential from the 27.5-volt supply through isolating resistor R116. The screen is bypassed by capacitor C145. The frequency-shift keyed heterodyning signals from the crystal-controlled oscillator are coupled to the injection grid through coupling capacitor C144. Dc return to ground is provided by resistors R112 and R113. Test point TP101 is provided at the junction of these resistors for checking the output of first crystal-controlled oscillator V102. Parallel-tuned circuit Z101 functions as the mixer plate load.

b. When the signals are mixed in the stage, their sum and difference frequencies and other products of the mixing action appear in the plate circuit of the tube. Tank circuit Z101 is tuned to 13.5 mc. This plate load impedance selects the sum frequency in the plate circuit, and attenuates unwanted signals generated in the mixing process. The signal voltage output from the plate of V101 is coupled through capacitor C148 and voltage divider resistors R118 and R119 to the input of band-pass filter FL103. The voltage divider provides a better impedance match between the mixer stage and the band-pass filter.

6. First Crystal-Controlled Oscillator V102

The first oscillator stage (fig. 6) consists of a type 26A6 pentode tube, in a crystal-controlled, electron-coupled Colpitts circuit. It provides the frequency-shift heterodyne signal for first mixer tube V101. The crystal-controlled oscillator is keyed to produce the frequency changes. The amount of change depends on the capacitance shunted across the crystal by the keying circuit. This, in turn, is determined by

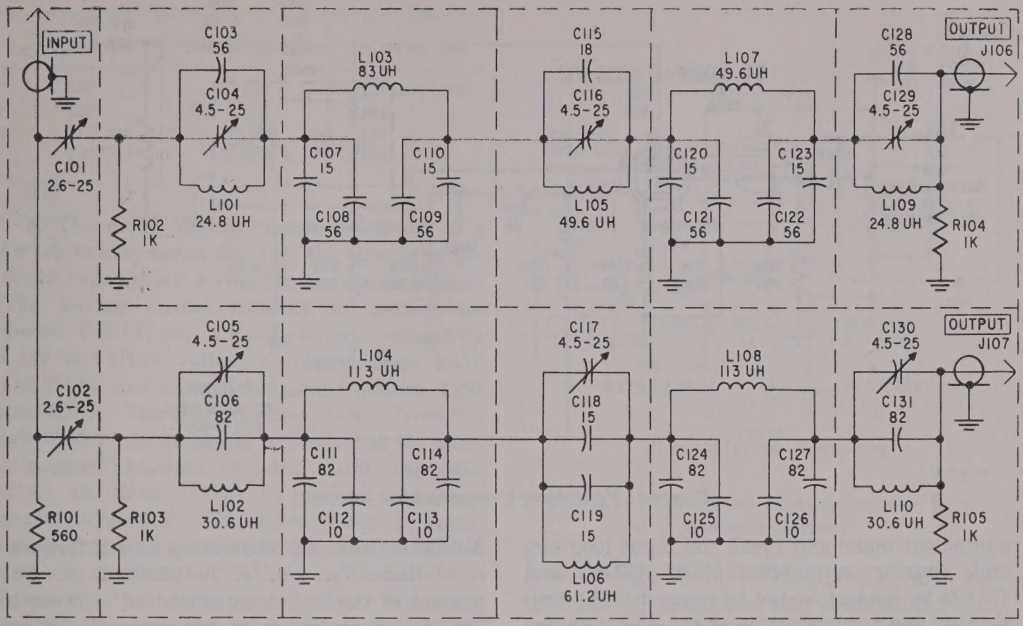


Figure 4. Dual low-pass input filter, FL101, schematic diagram.

the setting of MCS BAND SELECTOR switch S101. The crystal controls the stability of the frequencies generated by the oscillator circuit.

a. Quartz crystal Y101 has a natural frequency of 12 mc, and is located within a temperature controlled oven (HR101) which maintains a constant temperature to provide greater frequency stability. Crystal Y101 and grid resistor R114 are connected between the control grid of V102 and ground. The cathode of V102 is connected to ground through inductor L111 and series resistor R115. The voltage drop across R115 provides protective grid bias for V102. The protective bias prevents the tube from drawing too much plate current if the circuit oscillations should stop. Inductor L111 provides a higher cathode impedance so that the signal amplitude applied across C146 will be sufficient to sustain oscillations in the oscillator tank circuit. The oscillator-tuned circuit is made up of crystal Y101, capacitors C146 and C147, and the frequency-shift capacitors that are switched in the circuit for the desired frequency shift.

b. Capacitors C146 and C147 function as voltage dividers and also provide a center tap connection to the tank circuit. This arrangement is necessary to supply the correct phase and amplitude of feedback to the control grid. The screen grid voltage is supplied from the 27.5-volt source through isolating resistor R120. Capacitor C150 functions as the screen grid bypass capacitor. The signal voltage developed by the oscillator is applied to the injection grid of the mixer through coupling capacitor C144.

7. Frequency-Shift Keyer Circuit

The frequency-shift circuit (fig. 7) shifts the frequency of first crystal-controlled oscillator V102 to correspond to the keying impulses received from the teletypewriter transmitter unit. The keying impulses from the teletypewriter

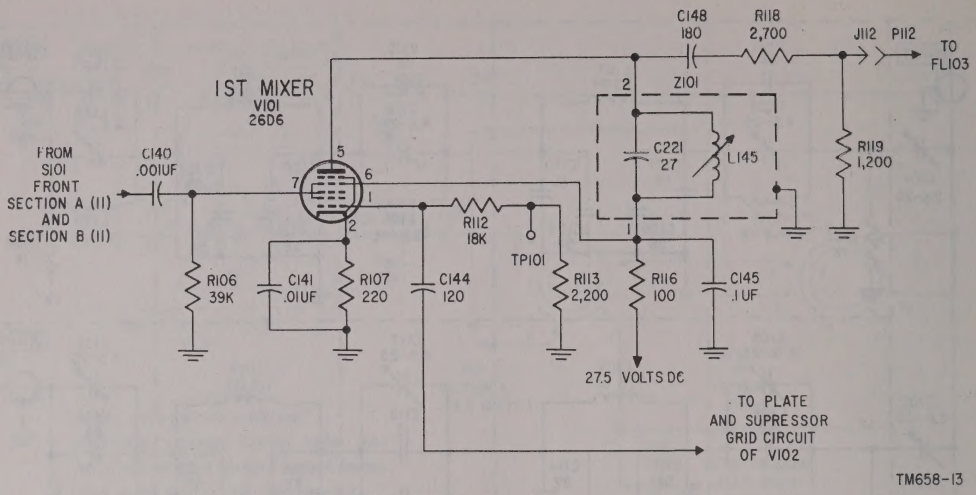


Figure 5. First mixer V101, schematic diagram.

equipment make and break the input loop circuit, causing germanium diodes CR101 and CR102 to conduct or not to conduct. The conduction and nonconduction of the diodes causes the capacitance in the grid circuit of the crystal oscillator tube to be reduced or increased. This action changes the frequency of the oscillator circuit.

a. The keying circuit provides four different values of capacitance to shunt Y101. These values are selected by 10-position MCS BAND SELECTOR switch S101C, thereby provided four different amounts of frequency shift. The shunt capacitance necessary to give the frequency shift required for a certain band of frequencies of the radio transmitter is selected by the setting of the MCS BAND SELECTOR switch. The added capacitance lowers the oscillator frequency by 850, 425, 212, or 106 cycles. Variable capacitors C138, C133, C132, and C 136, respectively, are connected between contacts 1 and 3, 5 and 7, and 9 on S101C (front) and ground. The switch arm of the front section connects to the control grid circuit; the switch arm of the rear section connects to the germanium diodes. As the MCS BAND SELECTOR switch is turned, the rear section selects the appropriate shunt capacitance to provide the amount of frequency shift required for the 850-cycle frequency shift in the output frequency of Radio Transmitter T–195/GRC–19. The amount of the frequency shift that is given to the master oscillator by the modulator is reduced by a factor equal to the amount of the frequency multiplication obtained in the subsequent stages in the exciter of the radio transmitter. Therefore, the amount of frequency shift produced in the cw output of the radio transmitter is 850 cycles.

b. The frequency shifts produced in the modulator at the various MCS BAND SELECTOR switch positions are listed below.

MCS BAND SELECTOR switch positions	Frequency shift (cps)	Transmiter exciter multiplication
1.5 - 1.7	850	1
1.7 - 2.0	850	1
2.0 - 2.4	850	1
2.4 - 3.0	850	1
3 - 4	425	2
4 - 6	425	2
6 - 9	212	4
9 - 12	212	4
12 - 16	106	8
16 - 20	106	8

c. The capacitors in the shunt circuits that are identified with the four frequency shifts are listed below:

Frequency shift	Trimmer capacitor	Fixed capacitor
850	C138	C139 and C149
425	C133	C134
212	C132	C135
106	C136	C137

d. The diode keying circuit functions as a switch to increase or decrease the amount of the shunt capacitance across the crystal oscillator. The keying circuit consists of germanium diodes CR101 and CR102, bypass capacitors C142 and C143, voltage divider resistor R110 and R111, and current limiting resistors R108 and R109. The external loop circuit from the teleprinter equipment is connected at the common point between resistor R109, capacitor C143, and diode CR102, to provide opens and shorts to ground. The selected shunt capacitance (connected through the arm of S101C (rear)) is connected to the junction point between the two germanium diodes. When the keying loop provides an open (space), both germanium diodes have positive voltages applied to their anodes. This permits current flow through them and reduces their resistances to a very low value. These low values of resistances effectively put the comparatively larger capacitances, C142 and C143, across the selected fixed capacitor, thereby shorting out the fixed capacitor. The corresponding series trimmer capacitor in the shunt circuit is thereby grounded, and the oscillator is then operating at the lower space shift frequency. When the external loop circuit provides a short, the anode of germanium diode CR102 is shorted to ground. The positive voltage is then applied through resistors R110 and R111 to the cathodes of the germanium diodes, and no current flows through them. The resistances of both germanium diodes are at a very high value which isolates capacitors C142 and C143 from the shunt capacitance circuit. The fixed capacitor is than in series with the trimmer capacitor, which reduces the shunt capacitance across the oscillator grid circuit and raises the frequency of the oscillator to the higher (mark) shift frequency. With the external loop circuit closed (mark), the higher shift frequency obtained

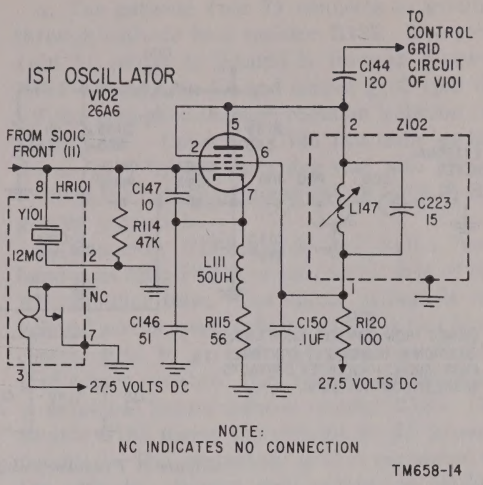


Figure 6. First crystal-controlled oscillator V102, schematic diagram.

goes through the modulator circuits and back to the radio transmitter and produces the higher shift frequency of the radio transmitter. With the external loop circuit open (space), the lower shift frequency is obtained, which produces the lower shift frequency of the radio transmitter.

8. Band-Pass Filter FL103

Band-pass filter FL103 (fig. 8) attenuates all the frequencies in the first mixer output other than the desired band of frequencies, 13.5 to 15 mc. The filter is connected between first mixer V101 and RF amplifier V103.

a. The parallel-tuned coils of the filter network are placed in separate compartments in the filter to provide adequate shielding. Feedthrough terminals are used for the connections between compartments for the 14 resonant circuits. The compartments are shielded and inclosed by the cover to provide a dust and moistureproof seal.

b. The oscillator-mixer chassis connects to INUT receptacle J113 on band-pass filter FL 103, through coaxial cable W117. INPUT receptacle J113 is mounted on the side of the compartment where the first parallel-tuned coil is located. From J113, the circuit is traced to the junction point of resistors R121 and R122.

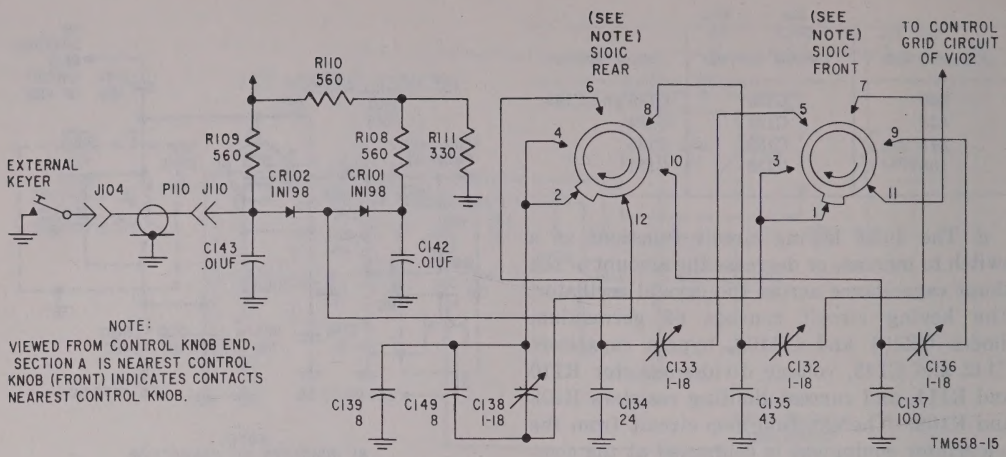


Figure 7. Frequency-shift circuit, schematic diagram.

(1) Resistor R122 is connected to ground and provides matching for the input circuit. Resistor R121 is connected to the first parallel-resonant circuit. The first parallel-tuned circuit consists of inductor L112, variable capacitor C 153, and fixed capacitors C151 and C152. Resistors R121 and R122 set the impedance at the input of the first parallel-resonant circuit to approximately 1,000 ohms.

(2) The signal continues through the parallel-resonant circuit made up of inductor L113, variable capacitor C154, and fixed capacitors C155 and C156.

(3) The signal is coupled by the feedthrough terminals to the next compartment. The parallel-tuned circuit in this compartment consists of inductor L114, variable capacitor C158, and fixed capacitor C157.

(4) The signal is then applied to the parallel-resonant circuit consisting of inductor L115, variable capacitor C159, and fixed capacitor C160.

(5) The signal is applied to the following parallel-tuned circuit consisting of inductor L116, variable capacitor C161, and fixed capacitor C162.

(6) The parallel-resonant circuit, consisting of inductor L117, variable capacitor C164, and fixed capacitor C163, is connected between this point and ground. The signal continues to the parallel-resonant circuit made up of inductor L118, variable capacitor C 166, and fixed capacitor C165.

(7) The signal continues through the parallel-resonant circuit made up of inductor L119, variable capacitor C167, and fixed capacitor C168.

(8) The signal continues through the parallel-tuned circuit made up of inductor L120, variable capacitor C169, and fixed capacitor C170.

(9) The parallel-resonant circuit, made up of inductor L121, variable capacitor C172, and fixed capacitor C171, is connected to the point between inductors L120 and L122 and ground. Inductor L122, variable capacitor C173, and fixed capacitor C174, form a parallel-resonant circuit. This tuned circuit is in series with the signal path.

(10) The signal is then applied across the parallel-tuned circuit made up of inductor L123, variable capacitor C176, and fixed capacitor C175. Inductor L124, variable capacitor C177, and fixed capacitors C178 and C179, com-

prise a resonant circuit in series with the signal path.

(11) The final paralled-tuned circuit is made up of inductor L125, variable capacitor C180, and fixed capacitors C181 and C182. From inductor L125, the signal is coupled to OUTPUT receptacle J114 through terminating resistor R123.

(12) The signal is coupled from OUTPUT receptacle J114 (of FL103) through coaxial cable W119 to receptacle J115 on the oscillator-mixer chassis. Capacitor C183 couples the signal to the control grid (pin 1) of V103.

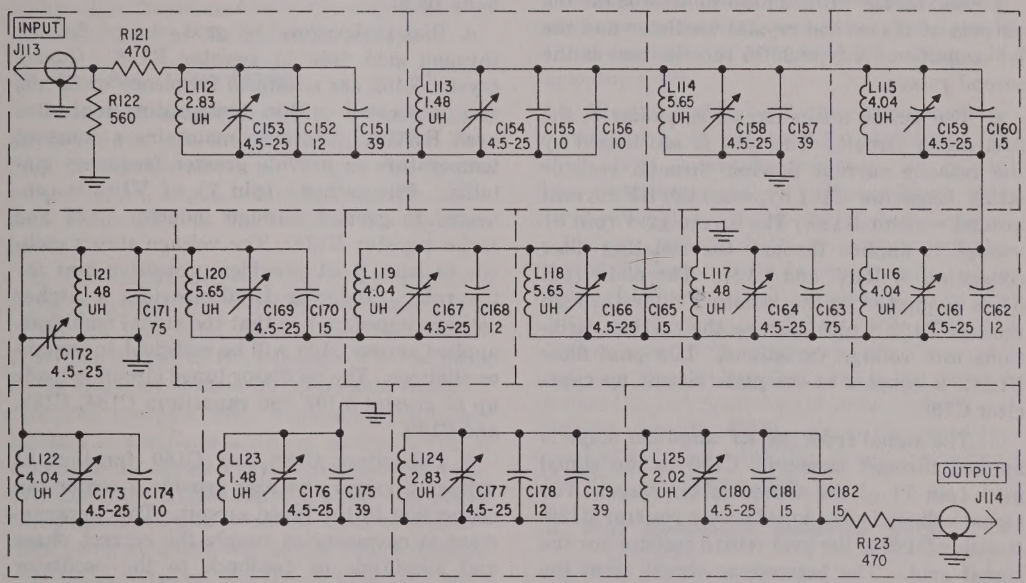
9. RF Amplifier V103

(fig. 9)

RF amplifier V103 uses a miniature pentode tube type 26A6 to amplify the signal from band-pass filter FL103. The amplified signal is then coupled to the second mixer stage.

a. The cathode (pin 7) connects to ground through cathode bias resistor R125. The grid (pin 1) return to ground is through resistor R124. Plate (pin 5) and screen grid (pin 6) voltage is applied through common isolation resistor R127. Capacitor C186 functions as the screen grid bypass capacitor and also serves to place the bottom of tuned circuit Z103 at RF ground potential.

b. Capacitor C183 couples the signal from band-pass filter FL103 to the control grid of the RF amplifier tube. The signal voltage is developed across resistor R124, which is tied from control grid to ground and functions as the grid return resistor. Bias voltage for the stage is developed across cathode resistor R125. Capacitor C185 places the cathode at RF ground potential. The suppressor grid is connected to the cathode. Screen grid voltage is applied through the isolating filter consisting of resistor R127 and capacitor C186. Plate voltage is applied through resistor R127 and tuned circuit Z103.



NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF
2. [ ] INDICATES EQUIPMENT MARKING.
3. K=1000 OHMS, MEG=MEGOHMS, UF=MICROFARADS.

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Figure 8. Band-pass filter FL103, schematic diagram.

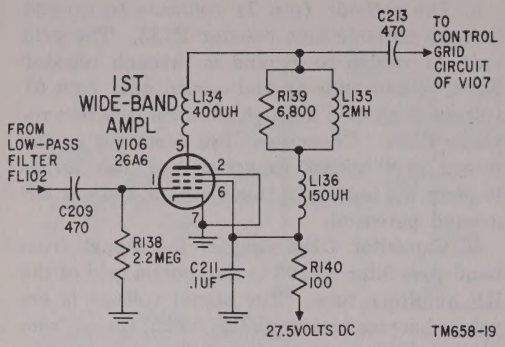


Figure 9. RF amplifier V103, schematic diagram.

c. Tuned circuit Z103 functions as the plate load and is tuned to 15 mc. The signal voltage is amplified by the tube and appears across the plate load (Z103). Resistor R150 broadens the selectivity curve of the resonant circuit.

10. Second Mixer V105

(fig. 10)

Second mixer V105 is used to heterodyne the outputs of the second crystal oscillator and the RF amplifier. A type 26D6 tube is used as the second mixer.

a. The second mixer circuit is similar to the first mixer circuit. The tube is self-biased by the cathode current flowing through resistor R130. Capacitor C191 bypasses the RF current around resistor R130. The screen grid (pin 6) voltage is applied through the isolating filter consisting of R133 and C194. The plate (pin 5) is connected to the isolating filter through resistor R132, which changes the current variations into voltage variations. Low-pass filter FL102 is coupled to the plate circuit by capacitor C193.

b. The signal from the RF amplifier stage is applied through capacitor C190 to the signal grid (pin 7) of the second mixer stage. The signal voltage is developed across resistor R129. Resistor R129 is the grid return resistor for the signal grid. The heterodyne signal from the second oscillator is coupled by capacitor C192 to the control grid (pin 1) of V105. Resistors R134 and R135 connected between the control grid and ground, provide a grid return and a dc test point (TP102) for checking the tuning of the second oscillator plate circuit. The signal and heterodyning frequencies are mixed in the tube and appear in the plate circuit as the sum and the difference frequencies of the two mixed signals. Low-pass filter circuit FL102 provides for the attenuation of the unwanted sum and higher frequencies while passing the wanted difference frequency in the band from 1.5 to 3.0 mc. At this point, and through the following stages, the frequency of the signal is the same as was originally received from the master oscillator of the radio transmitter.

11. Second Crystal-Controlled Oscillator V104

(fig. 11)

The second oscillator provides the injection signal for second mixer V105. This oscillator uses a type 26A6 pentode tube in a Colputts type circuit to generate a steady crystal-controlled 12-mc signal. Reconversion is accomplished in the second mixer stage from the 13.5- to 15-mc band to the original frequency in the 1.5- to 3-mc band.

a. Bias is developed by grid current flowing through grid (pin 1) resistor R128. Quartz crystal Y102 has a natural frequency of 12 mc, and is located within temperature-controlled oven HR102. The oven maintains a constant temperature to provide greater frequency stability. The cathode (pin 7) of V104 is connected to ground through inductor L126 and series resistor R131. The voltage across cathode resistor R131 provides protective bias for the tube. Inductor L126 provides a higher cathode impedance so that the signal amplitude applied across C189 will be sufficient to sustain oscillations. The oscillator tuned circuit is made up of crystal Y102 and capacitors C184, C188, and C189.

b. Capacitors C188 and C189 function as voltage dividers and also provide a center tap connection to the tuned circuit. This arrangement is necessary to supply the correct phase and amplitude of feedback to the oscillator control grid. The screen grid (pin 6) voltage is supplied from the 27.5-volt source through isolating resistor R136. The plate (pin 5) is also supplied from the same source through common resistor R136 and plate load Z104.

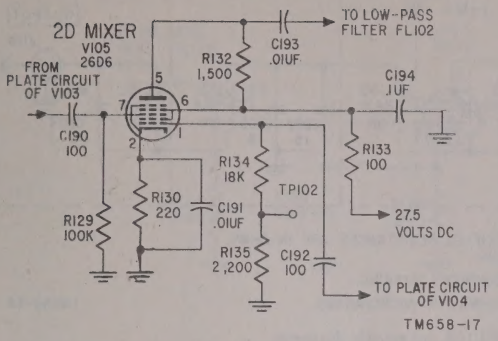


Figure 10. Second mixer V105, schematic diagram.

Capacitor C195 places the screen grid at RF ground.

c. Variable capacitor C184 permits adjustment of the oscillator frequency over a limited range to obtain zero-beat condition between the first and the second crystal oscillators. A zero-beat condition between the oscillators insures that the unshifted output frequency of the radio transmitter modulator will be within a very close tolerance of the input frequency.

12. Low-Pass Filter FL102

The output from the second mixer stage is applied to low-pass filter FL102 (fig. 12). This filter attenuates the sum frequencies in the second mixer output, while passing the difference frequencies in the required 1.5- to 3-mc band.

a. The output of the second mixer is coupled from receptacle J116 to INPUT receptacle J118 of the low-pass filter through coaxial cable W 109. The output of the low-pass filter connects to the amplifier chassis through cable W111.

b. The low-pass filter resonant circuits are inclosed in a six-compartment casting which is similar to the sealed FL101 filter castings (par. 4). The filter circuit consists of several parallel-resonant circuits with the coils of the circuits being mounted in separate compartments.

c. From INPUT receptacle J118, the filter circuit is traced to resistor R137 which has the other end connected to ground and sets the input impedance of the filter. The first parallel-resonant circuit, consisting of inductor L127

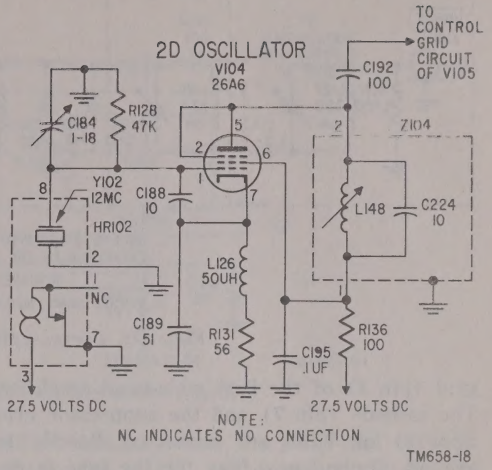


Figure 11. Second crystal controlled oscillator V104, schematic diagram.

and variable capacitor C197, is also connected to receptacle J118.

d. The circuit continues through the wall of the compartment to the second parallel-resonant circuit consisting of inductor L128 and variable capacitor C198.

e. From inductor L128, the circuit continues to inductor L129 and variable capacitor C199, which form a parallel-resonant circuit with fixed capacitors C200 and C201. These capacitors are part of the following tuned circuit.

f. From inductor L129, the circuit continues through inductor L130 to the junction of inductor L131 and fixed capacitors C202 and C203. Fixed capacitors C200, C201, C202, and C203 resonate with inductor L130. The circuit continues through inductor L131 to the parallel-resonant circuit consisting of inductor L132 and variable capacitor C204. From the other terminal of inductor L132, the circuit connects to OUTPUT receptacle J119.

13. First Wide-Band Amplifier V106 (fig. 13)

The first wide-band amplifier stage uses a type 26A6 pentode tube as a voltage amplifier of frequencies in the 1.5- to 3.0-mc band.

a. The output signal from FL102 is applied through coupling capacitor C209 to the control

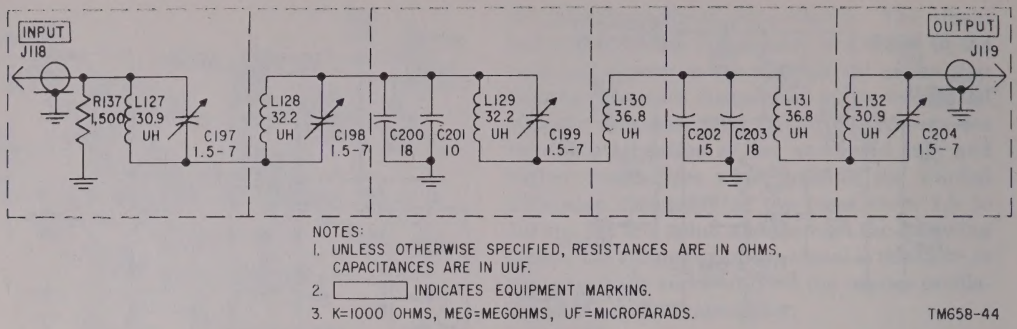


Figure 12. Low-pass filter FL102, schematic diagram.

grid (pin 1) of the first wide-band amplifier. The cathode (pin 7) and the suppressor grid (pin 2) of V106 are connected directly to ground. Control grid bias for the tube is developed by the grid leak action of resistor R138 and capacitor C209. The screen grid (pin 6) receives its voltage from the 27.5-volt supply line through the isolating filter consisting of resistor R140 and capacitor C211. The plate (pin 5) of the tube also receives its voltage from the isolating filter through peaking coil L136, plate load R139, shunting coil L135, and peaking coil L134. Plate load resistor R139 is shunted by inductor L135 to reduce the dc voltage drop through R139, while presenting a high impedance to the RF voltage developed at the plate of the tube.

b. The wide-band characteristics of the circuit are provided by peaking coils L136 and L134, which give uniform amplification over the 1.5- to 3.0-mc band pass.

14. Second Wide-Band Amplifier V107 (fig. 14)

The second wide-band amplifier stage uses a type 26A6 tube for amplification of the signal received from the output of V106 before transferring it to the grid of third amplifier tube V108.

a. The amplifier circuit of V107 is similar to the amplifier circuit of V106. Inductor L150 functions as the plate load. Coupling capacitor C215 connects the following stage to the plate circuit at the jnction of L149 and L150.

b. Peaking coils L149 and L150 function to give uniform amplification of the circuit as in the previous amplifier stage. The 33K resistors shunting the coils broaden the peaking effect of the coils.

15. Third Wide-Band Amplifier V108A

The third wide-band amplifier stage (fig. 15) uses one-half of a type 26A7 dual pentode for amplifying the output of second wide-band amplifier V107. Amplification is necessary to provide a suitable output level for reinsertion into the associated radio transmitter. The output of V108A is then applied to the other section of the same tube for additional amplification.

a. Capacitor C215 couples the signal to the control grid (pin 3) of V108A. The signal voltage is developed across resistor R144. The cathode (pin 2) of both sections of the dual tube are tied together internally resulting in the total tube currents flowing through cathode resistor R145. Cathode bias voltage is developed across this resistor. Capacitor C116 prevents degenerative action occurring in the two tube sections. Operating potential for the screen grids (pin 5) of both sections of the tube is taken from isolating filter resistor R149 and capacitor C220. Plate (pin 4) voltage is applied through isolating resistor R149, inductor L141, and the parallel network consisting of resistor R146 and inductor L140. Inductor L140 reduces the total dc resistance in the plate circuit. Resistor R146 is the plate load for the stage.

b. Inductor L141 is a shunt peaking coil. Inductor L151, shunted by a 33K resistor, is a

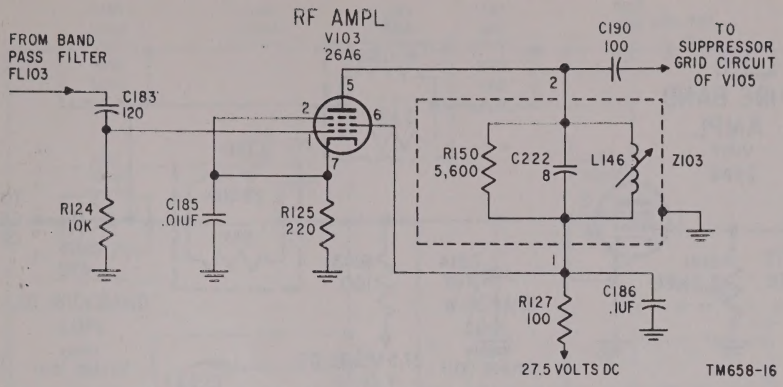


Figure 13. First Wide-band amplifier V106, schematic diagram.

series peaking coil. They are used to obtain uniform amplification over the pass band. The output of the stage is taken from the plate through inductor L151 and capacitor C217, and coupled to the grid of V108B.

16. Fourth Wide-Band Amplifier V108B

The fourth wide-band amplifier stage (fig. 15) uses the second half of tube V108 to provide additional signal amplification. The amplified signal is then applied to the FSK OUTPUT receptacle at a suitable voltage level for reinsertion into the associated radio transmitter.

a. The signal from the plate circuit of V108A is coupled by series peaking coil L151 and coupling capacitor C217 to the control grid (pin 1) of V108B. The signal voltage is developed across grid return resistor R147. Screen (pin 5) voltage for V108B is furnished by the 27.5-volt supply through resistor R149. Resistor R149 and capacitor C220 form a decoupling filter which bypasses RF signals from screen to ground. Plate (pin 8) voltage is furnished by the same 27.5-volt source through resistor R149, peaking coil L143, plate load resistor R148 (shunted by L142) and peaking coil L144. The dc resistance of the plate load for V108B is reduced by shunting plate load resistor R148 with inductor L142. Trap circuit Z105 (par. 17) is connected to the grid circuit of V108B by relay K101 and capacitor C218.

b. Tube V108B amplifies the signal supplied between grid and cathode and develops the amplified voltages across the plate load network (R148 and L142). The output signals are coupled by capacitor C219 to FSK OUTPUT receptacle J103.

17. Trap Circuit Z105

Trap circuit Z105 (fig. 15) is designed to suppress frequencies at and near 3 mc. Frequencies at or near 2.25 mc are boosted in amplitude.

a. The trap circuit presents a high impedance to frequencies from 1.5 to 2.25 mc and suppresses the frequencies around 3 mc (the second harmonic of 1.5 mc) due to the series-resonant action of capacitor C212 and inductor L137B. Relay K101 is used to avoid capacitance that would be added to the grid circuit if the connection were made through a switch. When MCS BAND SELECTOR switch S101 is in a position where the 2.6-mc output from the low-pass filter is used, trap Z105 is connected to the grid. The switch arm of switch S101B (rear) is connected to the 27.5-volt line. Contacts 1, 2, 5, 7, and 9, are tied together and connected to the coil of relay K101, and the other end of the relay coil is connected to ground. Relay K101 is energized by the switch.

b. Capacitor C210 bypasses undesired transients that are produced by the relay contacts. Trap circuit Z105 is made up of series capacitor C212 and inductor L137B, in shunt with inductor L137A and resistor R151. Resistor R151,

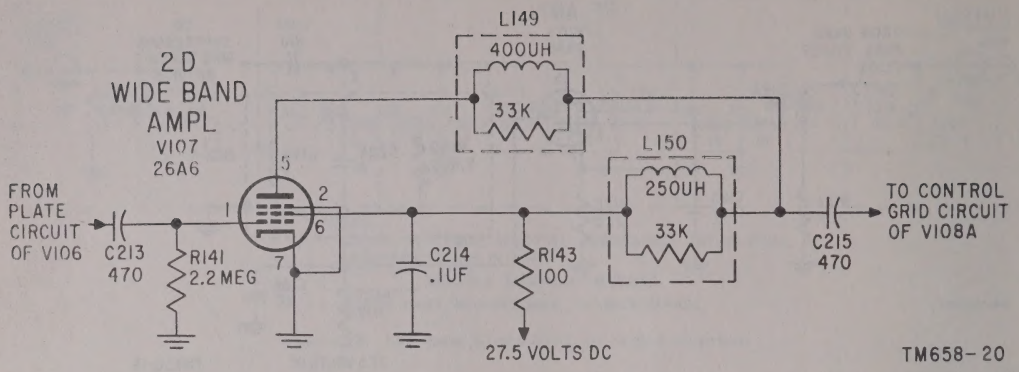


Figure 14. Second wide-band amplifier V107, schematic diagram.

shunting inductor L137A, reduces excessive peaking.

18. Power Application

(fig. 16)

The primary power for the modulator is 27.5 volts dc. The power input is filtered to prevent noise and other disturbances from getting into the modulator. The primary power supply circuit supplies all the heater, screen grid, and plate voltages of the tubes. No high voltage power supply is used.

a. The positive wire of the power cable connects to pins A and B of the 27.5 VOLTS D.C. receptacle. The negative wire connects to pins C and D of the receptacle. Pins C and D connect to chassis ground. Fuse F101 (3 AMP) protects the power supply circuit. POWER switch S101 connects or disconnects the power line to the modulator. When power is applied, power indicator lamp I 101 glows.

b. The power supply filter consists of inductor L133 and capacitors C205, C206, C207, and C208. The filter prevents noise, miscellaneous transient disturbance, and RF that may be in the power line, from getting into the modulator circuits, and also prevents the radio frequencies that originate in the modulator from getting into the power line. Capacitors C205 and C208 bypass the higher frequencies.

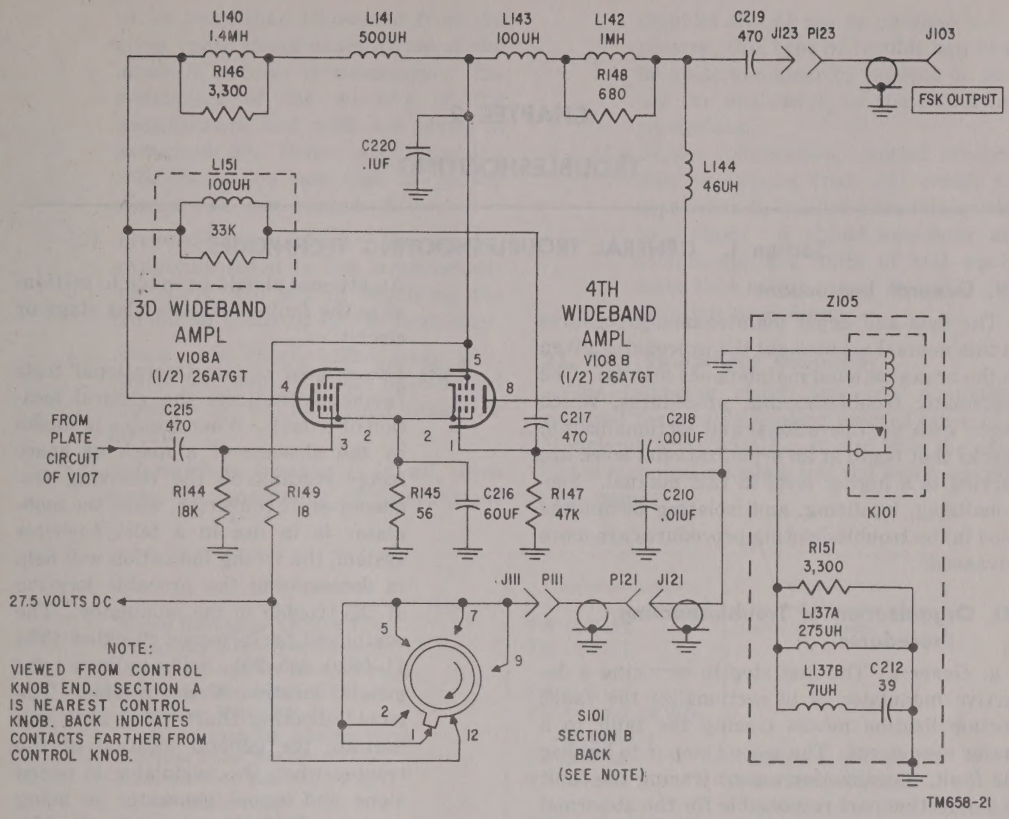


Figure 15. Third and fourth wide-band amplifiers V108A and V108B, schematic diagram.

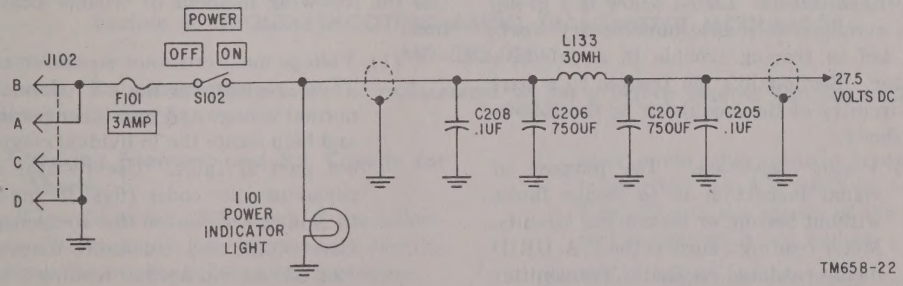


Figure 16. Power supply circuit, schematic diagram.

CHAPTER 2

TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

19. General Instructions

The field and depot maintenance procedures in this manual *supplement* the procedures given in the organizational maintenance manual. The systematic troubleshooting procedures, which begin with the operational and sectionalization checks that begin at an organizational level, are carried to a higher level in this manual. Sectionalizing, localizing, and isolating techniques used in the troubleshooting procedures are more advanced.

20. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective modulator is to sectionalize the fault. Sectionalization means tracing the fault to a major component. The second step is to localize the fault. Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, arcing, and shorted transformers can often be located by sight, smell, and hearing. The majority of faults, however, must be isolated by checking voltages and resistances. Operation of relay K101 can be determined by listening for clicks.

b. Sectionalization. Listed below is a group of tests arranged to reduce unnecessary work, and to aid in tracing trouble in a defective modulator. Sectionalize the trouble to a part of the circuitry of the modulator by the following methods:

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. Meter readings, such as the P.A. GRID meter readings on Radio Transmitter T–195/GRC–19 (TM 11–806), or other visual signs should be observed. An attempt should be made to sectionalize the fault to a particular stage or circuit.

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. When trouble is shown by the absence of a mark or space meter reading on the receiving frequency-shift converter, when the modulator is in use in a teletypewriter system, the wrong indication will help in determining the probable location of the trouble in the modulator. The equipment performence checklist (TM 11–5820–205–20) will indicate the general location of the trouble. The troubleshooting chart (par. 24*d*) will indicate the general location of the trouble when the modulator is tested alone and signal generator is being used to supply the signal to the MO INPUT receptacle.

c. Localization. The tests listed below will aid in isolating the trouble. First, localize the trouble to a single stage or circuit, and then isolate the trouble within that circuit by voltage, resistance, and continuity measurements. Use the following methods of trouble localization:

(1) *Voltage and resistance measurements.* These measurements will show abnormal voltage and resistance readings and help locate the individual component part at fault. Use resistor and capacitor color codes (figs. 33 and 34) to find the value of the components. Use voltage and resistance diagrams (fig. 23) to find normal readings, with no signal, and compare them with the readings taken. If a measured value

varies more than 10 percent from the given value, closer examination of the involved circuits is necessary. The resistances of the winding of the transformers and coils are given in paragraph 28. Before making resistance checks, be sure that the power sources has been turned off.

(2) *Troubleshooting chart.* The trouble symptoms listed in the troubleshooting chart will aid in localizing the trouble to a circuit of the modulator.

(3) *Stage gain chart.* The stage gain charts will help to locate hard-to-find troubles in an individual stage or circuit.

(4) *Intermittent troubles.* In all these tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble can often be made to appear by tapping or jarring the modulator, or the cables and connectors.

(5) *Signal substitution.* Signal substitution procedures (par. 25) enable the repairman to localize a trouble quickly to a stage. A signal generator and oscilloscope are units of test equipment that may be used in signal substitution procedures.

21. Test Equipment Required

The following chart lists test equipment required for troubleshooting Radio Transmitter Modulator MD–203/GR. It also lists the associated technical manuals and the assigned common names.

Test equipment	Technical manual	Common name
Signal Generator AN/URM–25	TM 11–5551	Signal generator
Frequency Meter AN/USM–26 (4th through 5th echelons only)	TM 11–5057	
Frequency Meter AN/URM–32	TM 11–5120	
Frequency Meter FR–67/U (4th through 5th echelons only)	TM 11–2698 (MWO–11–2698–1)	
Electron Tube Test Set TV–7/U	TM 11–5083	Tube Tester TV–7/U
Electron Tube Test Set TV–2/U (5th echelon only)	TM 11–2661	Tube Tester TV–2/U
Multimeter AN/URM–105	TM 11–6625–203–12	Multimeter
Electronic Multimeter TS–505/U	TM 11–5511	Electronic multimeter
Crystal Impedance Meter TS–683/TSM (4th through 5th echelons only)	TM 11–2652	Impedance meter
Grid Dip Meter (nomenclature to be assigned (5th echelon only))		Grid dip meter
Oscilloscope OS–8A/U	TM 11–1214	Oscilloscope

Section II. TROUBLESHOOTING RADIO TRANSMITTER MODULATOR MD–203/GR

Caution: **Do not attempt removal or replacement of parts before reading the instructions in paragraphs 30 and 31.**

22. Checking Filament and B+ Circuits for Shorts

a. When To Check. When any of the following conditions apply, check for short circuits and clear the trouble before applying power.

(1) When the modulator is being serviced apart from other units of Radio Teletypewriter Set AN/GRC–46 or AN/VRC–29 and the nature of the abnormal symptoms is not known.

(2) When abnormal symptoms reported from operational tests indicate pos-

sible shorts (item 5, Equipment Performance Check List (TM 11–5820–205–20)).

b. Conditions for Tests. To prepare for the short-circuit tests, perform the following steps:

(1) Place the MAIN POWER circuit breakers at OFF.

(2) Remove the modulator from the mounting (par. 15, TM 11–5820–205–20).

(3) Remove the modulator from its case (par. 31*a*(2)).

(4) Disconnect the input power.

(5) Remove all the tubes and the indicator lamp.

(6) Turn the POWER switch to ON.

c. Measurements. Make the resistance measurements indicated in the following chart. If abnormal results are obtained, make the additional isolating checks outlined. When the faulty part is found, repair the trouble before applying power to the unit. Measurements are made between the check point and ground, unless otherwise stated.

Point of measurement	Isolating procedure	Normal indication
Between terminals A or B, and C or D of J102 (fig. 35).	Turn POWER switch to OFF. A low resistance reading indicates a short circuit in J102, in the fuse holder, or in S102. Remove F101 to isolate the short to either J102 or S102. A low resistance reading with F101 removed, indicates a short in J102.	Infinity
Between terminals A or B, and C or D of J102 (fig. 35).	Replace fuse F101. Remove the two crystal holders, and the pilot lamp. Turn POWER switch to ON. Check the capacitors and resistors connected to the 27.5-volt dc supply circuit. Open the 27.5-volt supply circuit at some key point, such as one side of choke L133, to localize the short.	850

23. Test Setup
(fig. 17)

Bench tests of the modulator require connection to a power supply and to various test equipments. The power source must be connected to the modulator for all dynamic-servicing procedures; the test equipment connections vary from test to test. Remove the modulator chassis from the case (par. 31*a*(2)), and make a test setup as outlined below:

a. Power Supply Connections.

(1) Use Power Supply PP–1423/U in bench tests of the modulator. Connect Power Supply PP–1423/U to the power connector of the modulator through Electrical Power Cable Assembly CX–4540/U. Connect the power source positive wire to pins A and B of the plug, and the negative wire to pins C and D.

(2) If Power Supply PP–1423/U is not available, use an equivalent power source capable of supplying 27.5 volts at 1.8 amperes dc.

b. Test Equipment Connections (fig. 17). Connect the test equipment as specified for the particular tests. Use Electronic Multimeter TS–505/U to measure the alternating-current (ac) voltages, and Signal Generator AN/URM–25 to generate an unmodulated 2.0-mc signal. Apply the signal to pin 1 of V108 for the first test in paragraph 24*d*. The output voltage at J123 is measured with Electronic Multimeter TS–505/U. Oscilloscope OS–8A/U may be used to display the signal that exists at any point in the circuitry. Refer to the appropriate technical manual (par. 21) for instructions on how to operate the oscilloscope. Connect Frequency Meter AN/USM–32 ANT receptacle to the FSK IN receptacle on the transmitter. Using a cord and T-connector, make the connection to the T-connector at the FSK OUTPUT receptacle on the modulator.

24. Localizing Troubles

a. General. Procedures are outlined in the following chart for localizing trouble in the modulator by signal substitution and by circuit measurements. Depending upon the nature of the operational symptoms, one or more of the localizing procedures will be necessary. When use of the procedures results in localization of trouble to a particular stage, use the techniques outlined in paragraph 27 to isolate the trouble to a particular part in the stage or circuit. Parts locations are indicated in figures 18 through 22.

b. Use of Chart. The troubleshooting chart is designed to supplement the tube testing techniques (TM 11–5820–205–20) and the equipment performance checklist (TM 11–5820–205–20). If previous operational checks have resulted in reference to a particular item of this chart, go directly to the referenced item.

Caution: **If operational symptoms are not known, or they indicate the possibility of short circuits within the modulator, make the short-circuit checks described in paragraph 22 before applying power to the unit.**

c. Conditions for Tests. All the dynamic checks in the chart are to be conducted with the modulator conected to a power source as described in paragraph 23*a*. The signal generator, multimeter, frequency meter, and other test equipment are to be connected to various points in the circuits, as directed throughout the chart. Connect a .05-microfarad capacitor to the signal generator output lead. The subchassis will have to be removed (pars. 31 and 32), turned over, and the cabling reconnected. The MCS BAND SELECTOR switch should be in the 2.4-2.0 position except for items number 5 and 12 of the troubleshooting chart. Except for the overall voltage output test, the modulator chassis must be removed from the case.

d. Troubleshooting Chart.

Note. Perform the operations given in the equipment performance checklist (TM 11–5820–205–20) before using this char, unless the trouble has already been sectionalized.

Item	Indication	Probable trouble	Procedure
1	Indicator lamp does not light with modulator at ON.	Lamp burned out	Check indicator lamp.
		Battery or battery cables defective.	Check battery cables and battery voltage.
		Blown fuse F101	Replace blown fuse F101.
		Defective switch S101	Check continuity of switch S101.
2	No output from modulator when a signal of 2 mc at 960,000 microvolts is applied to pin 1 of V108.	Defective fourth amplifier stage.	Check V108 by substitution. Make voltage and resistance measurements (fig. 23).
3	No output from modulator when a signal of 2 mc at 120,000 microvolts is applied to pin 3 of V108.	Defective third amplifier stage.	Check V108 by substitution. Make voltage and resistance measurements (fig. 23).
4	No output from modulator when a signal of 2 mc at 9,000 microvolts is applied to pin 1 of V107.	Defective second amplifier stage.	Check V107 by substitution. Make voltage and resistance measurements (fig. 23).
5	No output from modulator when a signal of 2 mc at 1,000 microvolts is applied to J120.	Defective first amplifier stage.	Check V106 by substitution. Check for short between J120 and ground. Make voltage and resistance measurements (fig. 23).
6	No output (or weak output) from modulator when a signal of 2 mc at 1,100 microvolts is applied to J118.	Defective low-pass filter FL102.	Check for continuity between J118 and J119. Check for shorts between receptacles and ground. Check FL102 by substitution.

Item	Indication	Probable trouble	Procedure
7	No output (or weak output) from modulator when a signal of 14 mc at 1,000 microvolts is applied to J115.	Defective RF amplifier V103	Check V103 and V105 by substitution. Make voltage and resistance measurements on RF amplifier and second mixer stages (fig. 23).
		Defective second oscillator V104.	Check V104 by substitution. Make voltage and resistance measurements on second oscillator (fig. 23). Check Y102 by substitution. Check oscillator frequency (par. 42). Aline Z103 and Z104 (par. 39).
8	No output (or weak output) from modulator when a signal of 14 mc at 6,000 microvolts is applied to J113.	Defective band-pass filter FL103.	Check for continuity between J113 and J114. Check for shorts from receptacles to ground. Check FL103 by substitution.
9	No output (or weak output) from modulator when a signal of 2 mc at 168,000 microvolts is applied to J108.	Defective first mixer stage..... Defective first oscillator stage..	Check V101 by substitution. Make voltage and resistance measurements on first mixer stage. Check V102 by substitution. Check first oscillator frequency (par. 42). Make voltage and resistance measurements (fig. 23). Aline Z101 (par. 40) and Z102 (par. 39).
10	No output (or weak output) from modulator when a signal of 2 mc at 24,000 microvolts is applied to J109 with MCS BAND SELECTOR switch turned to 2.0-2.4 position.	Defective switch S101B (front). Defective cable.....	Check for continuity from J109 through the circuits of S101B (front). Check for shorts to ground in cable.
11	No output (or weak output) from modulator when a signal of 2 mc at 1.5 volts is applied to MO INPUT receptacle J101.	Defective cables, connectors, or switch contacts. Defective low-pass input filter FL101.	Check cables W101, W105, connectors, and S101B (front) for continuity and shorts to ground. Make resistance measurements on input filter (fig. 35).
12	No output from modulator when a signal of 2 mc at 1.5 volts is applied to MO INPUT receptacle J101 with the MCS BAND SELECTOR switch in the 1.5-1.7 position.	Defective cables, connectors, or switch contacts in circuit.	Check cable W103, connectors, and S101A for shorts to ground. Make resistance measurements on input filter (fig. 35).

25. Signal Substitution

Signal substitution procedures assist the repairman in localizing trouble to a stage of a defective modulator. A signal generator is used to inject an appropriate signal at the input of a stage to check the performance of the suspected stage. The amount of signal voltage injected must not be greater than the maximum voltage present at that point during normal operation (par. 26). The substituted signal may be injected at the plate or grid circuits of a stage through an isolating capacitor. The capacitor is used to prevent possible damage to the signal generator from dc voltages. The ground

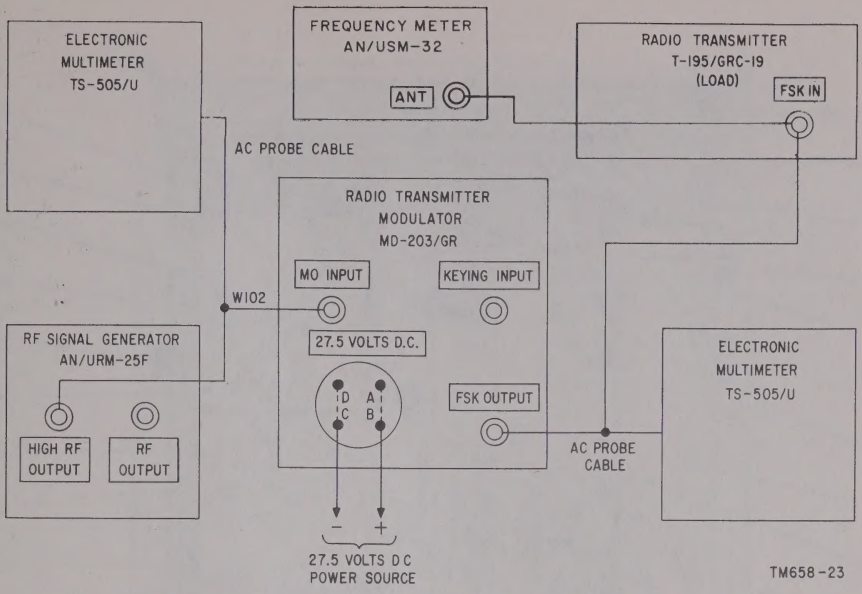


Figure 17. Test setup for troubleshooting.

lead of the signal generator is connected to chassis throughout the signal substitution procedures. The test equipment required is listed in paragraph 21. Connect the ac voltmeter between J123 and chassis. For each stage, adjust the signal generator to give an indication on the ac voltmeter of approximately 5 volts. Start with step number 3 of the troubleshooting chart (par. 24*d*), and continue through the last step of the chart.

26. Stage Gain Measurements

Use the techniques outlined in *a* through *d* below when the output of the modulator is abnormally low (items 2 and 3 of the equipment performance checklist (TM 11–5820–205–20) and items 6 through 11 of the troubleshooting chart (par. 24*d*). The stage gain charts contained in this paragraph list the minimum and maximum voltages required at each of the amplifier stages of the modulator to produce 5 volts ac between J123 and ground. Use these charts as a standard when troubleshooting to check the overall gain of the modulator and the gain of each amplifier stage. When the modulator output is low and the tubes are operating satisfactorily (as indicated by a tube checker), localize the defective stage by checking the signal-voltage level of each stage against the chart.

a. General Instructions. To obtain the stage gain reading, connect the electronic multimeter between J123 and ground. Connect the ground lead of the signal generator (calibrated output) to the modulator chassis. Connect the generator output lead through a .05-microfarad (μ) capacitor to the modulator points indicated in the chart. Check the output from the signal generator required to obtain the reference voltage of 5 volts ac (at J123) against the figures given in the charts. The lowest figure is the minimum, and the highest is the maximum that should be required over the specified frequency range for normal operation; however, a reading that is slightly different from the value given does not necessarily indicate improper functioning.

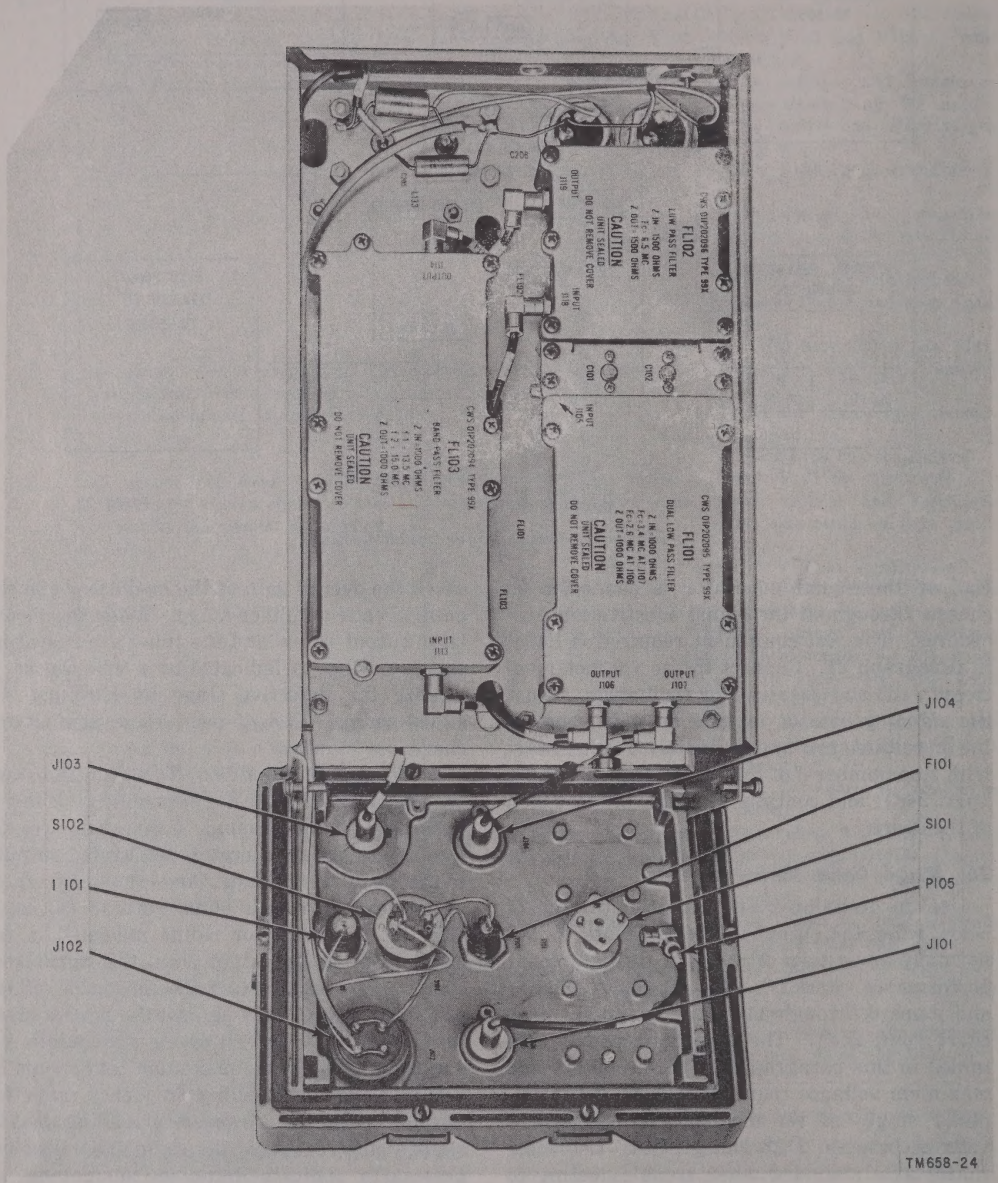


Figure 18. Radio Transmitter Modulator MD–203/GR, bottom view, front panel removed.

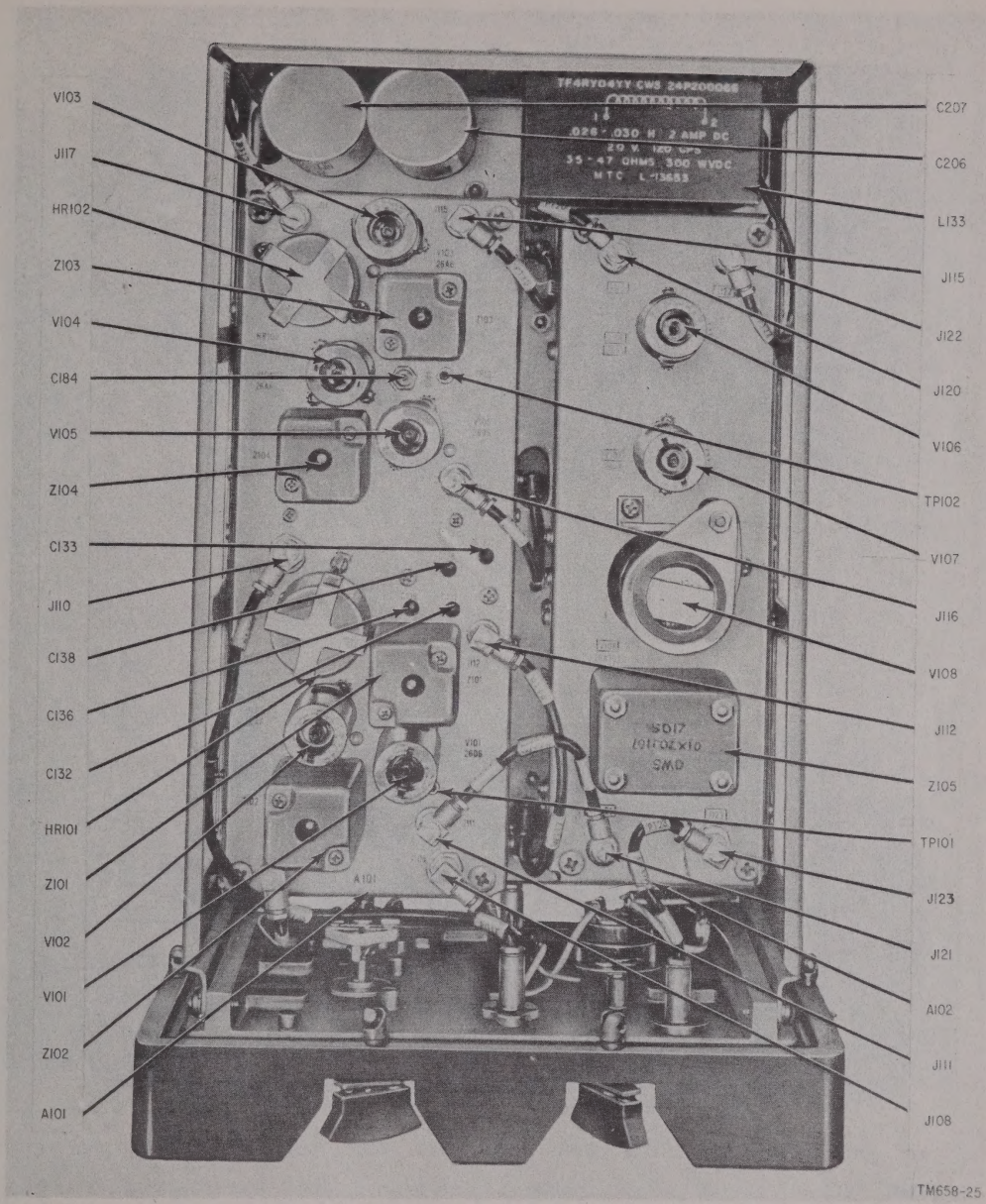


Figure 19. Radio Transmitter Modulator MD–203/GR, top view.

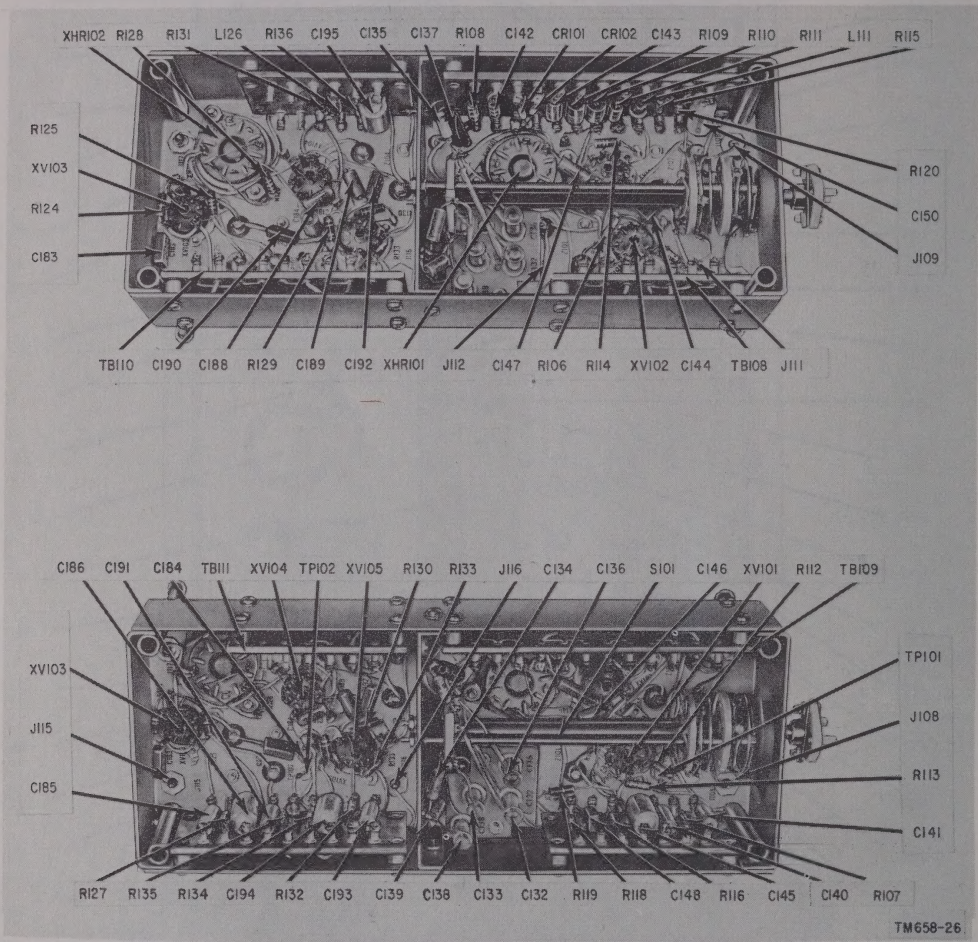


Figure 20. Radio Transmitter MD–203/GR, bottom view of A101.

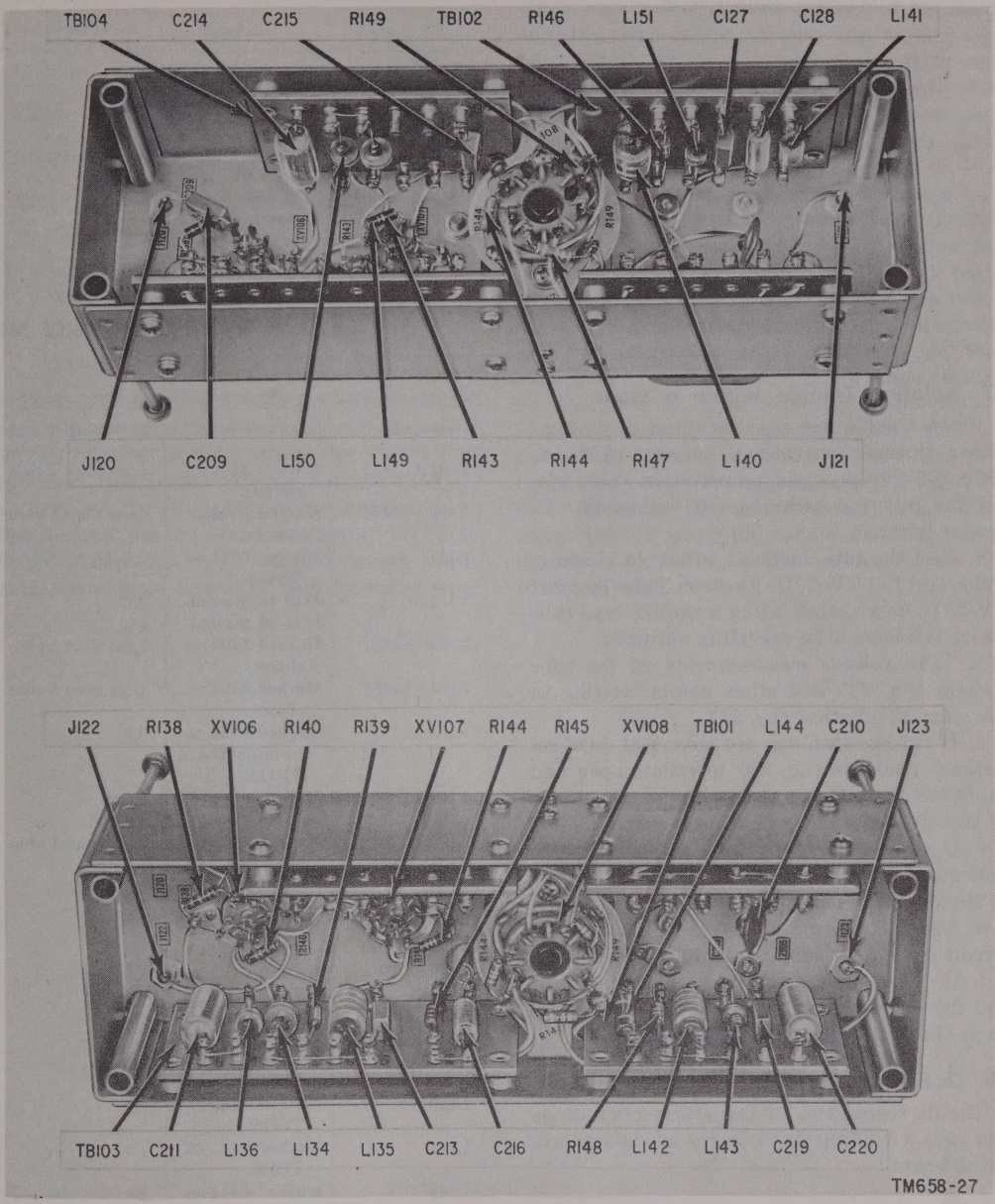


Figure 21. Radio Transmitter Modulator MD–203/GR, bottom view of A 102.

b. Stage Gain Chart.

Signal generator output connection	Frequency (mc)	Signal generator output
	Wide-band stages	
Pin 1 (grid) of V108	1.5 to 3	.5 to 1 volt
Pin 3 (grid) of V108	1.5 to 3	100,000 to 150,000 uv
Pin 1 (grid) of V107	1.5 to 3	8,000 to 10,000 uv
Pin 1 (grid) of V107	1.5 to 3	800 to 1,200 uv
Pin 7 (grid) of V105	1.5 to 3	100 to 300 uv
	Radio-frequency stages	
Pin 1 (grid) of V103	13.5 to 15	800 to 1,200 uv
Pin 7 (grid) of V101	13.5 to 15	800 to 1,200 uv
	Intermediate-frequency circuit	
MO INPUT (J101)	1.5 to 3	1 to 2 volts

27. Isolating Trouble Within a Stage

When trouble has been localized to a stage, either through operational checks (TM 11–5820–205–20) or signal substitution (par. 25), use the folowing techniques to isolate the defective part:

a. Test the tube involved, either in Electron Tube Test Set TV–7/U, Electron Tube Test Set TV–2/U, or by substituting a similar type tube which is known to be operating normally.

b. Take voltage measurements at the tube sockets (fig. 23) and other points relating to the stage in question (fig. 35).

c. If voltage readings are abnormal, take resistance readings (fig. 23) to isolate open and short circuits. Refer also to the dc resistance of transformers and coils in paragraph 28.

d. If signals are weak and all checks fail to indicate a defective part, check the alinement of the circuits (pars. 39–43) may be required.

e. Use the schematic diagram (fig. 35) to circuit trace and isolate the faulty component.

f. If the signals are weak after alinement, and the usual checks fail to locate a defective part, check the stage gain (par. 26).

28. Dc Resistances of Transformers and Coils

The dc resistances of transformer windings and coils (winding only) in the modulator are listed below:

Transformer or coil	Terminals	Ohms ±10%
FL 101	J105 to ground....	560
	J106 to ground....	500
	J107 to ground....	500
Z101 (L145)	Marked Z101 on chassis.	Less than 1 ohm
Z102 (L147)	Marked Z102 on chassis.	Less than 1 ohm
L111	Marked L111 on TB109.	3.8
FL 103	J113 to ground....	257
	J114 to ground....	470
Z103 (L146)	Marked Z103 on chassis.	Less than 1 ohm
Z104 (L148)	Marked Z104 on chassis.	Less than 1 ohm
L126	Marked L126 on terminal board TB111.	3.8
FL102	J118 to ground....	1,500
	J119 to ground....	1,500
L133	Marked L133 on chassis.	Less than 1 ohm
L134	Marked L134 on TB103.	23
L135	Marked L135 on TB103.	33
L136	Marked L136 on TB103.	8.5
L149	Marked L149 on TB104.	13
L150	Marked L150 on TB104.	11
L140	Marked L140 on TB102.	22
L141	Marked L141 on TB102.	7.5
L142	Marked L142 on TB101.	23
L143	Marked L143 on TB101.	6.2
L144	Marked L144 on TB101.	Less than 1 ohm

Transformer or coil	Terminals	Ohms ±10%
L151	Marked L151 on TB102.	6
L137A	Coil alone in unit.	3
L137B	Coil terminals in unit.	13
K101	Center terminal and ground of receptacle J121.	500

29. Checking Voltages at Tubes

(fig. 23)

To avoid removing a resistor board or other part when voltage is to be measured at a tube socket, remove the tube, insert the proper test socket in Test Socket Adapter Kit MX-1258/U, and replace the tube. Make the connection to the desired pin on the test socket. If Test Socket Adapter Kit MX–1258/U is not available, use a short length of thin insulated wire (both ends bared), insert one end of the wire in the desired socket contact, and replace the tube. Make the connection to the exposed end of the wire. The voltage and resistance diagram for the modulator (fig. 23) shows the values which should be obtained at the tube socket pins. If a value, as indicated on the multimeter, varies (outside of reasonable tolerance limits) from the value given in the diagrams, the amount of variance should be noted and used when determining which part is at fault. For instance, if 20 volts is indicated at a given tube socket pin on a diagram and the actual indication is 5 volts on the meter, the circuit diagram of the stage should be examined for a part in the circuit under test which could, if defective, cause the incorrect reading. Possibly a resistor has increased in ohmic value or a capacitor has become leaky in the circuit under test. The many ways of using the voltage and resistance diagrams depend upon the resourcefulness of the repairman.

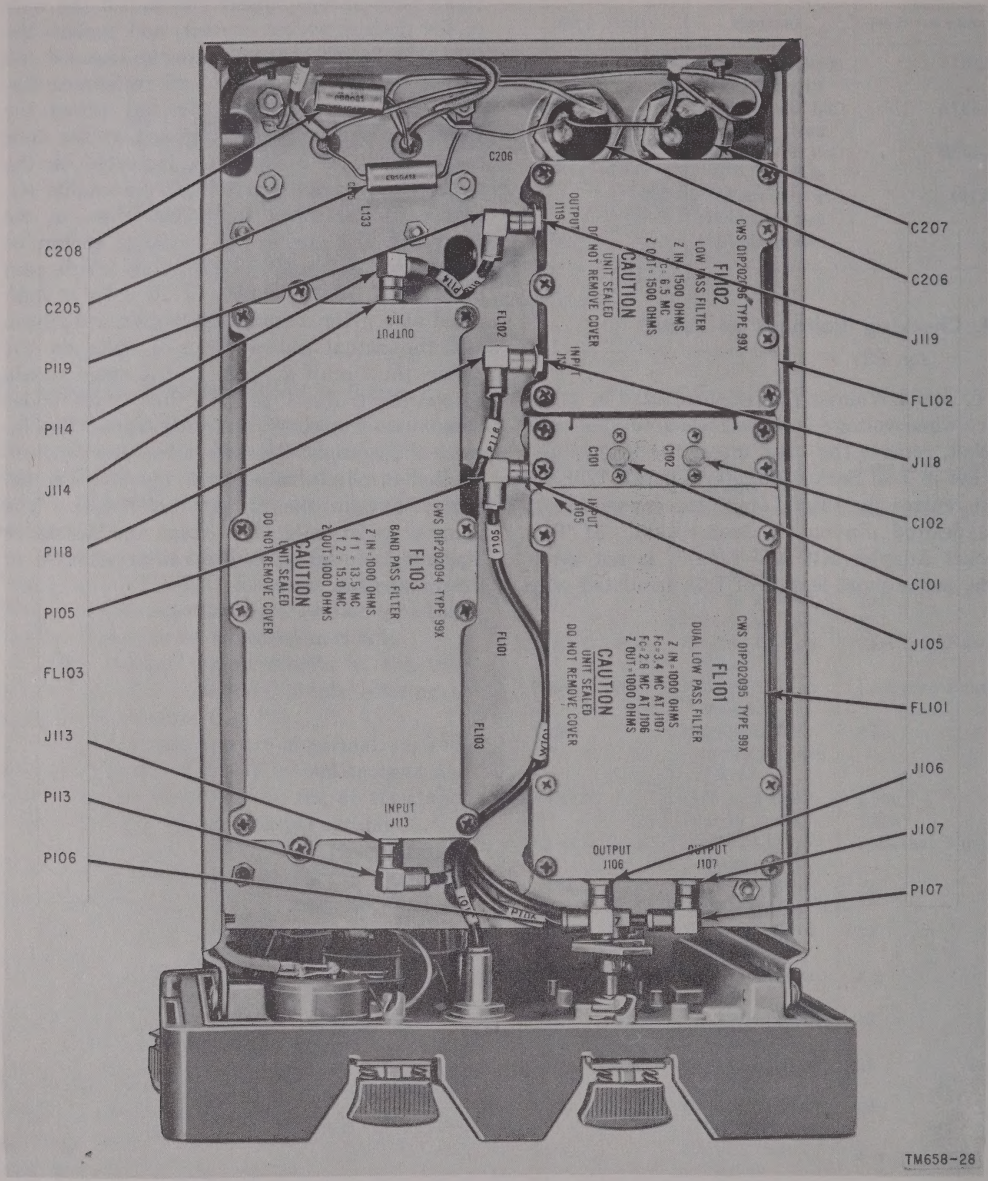


Figure 22. Radio Transmitter Modulator MD–203/GR, bottom view.

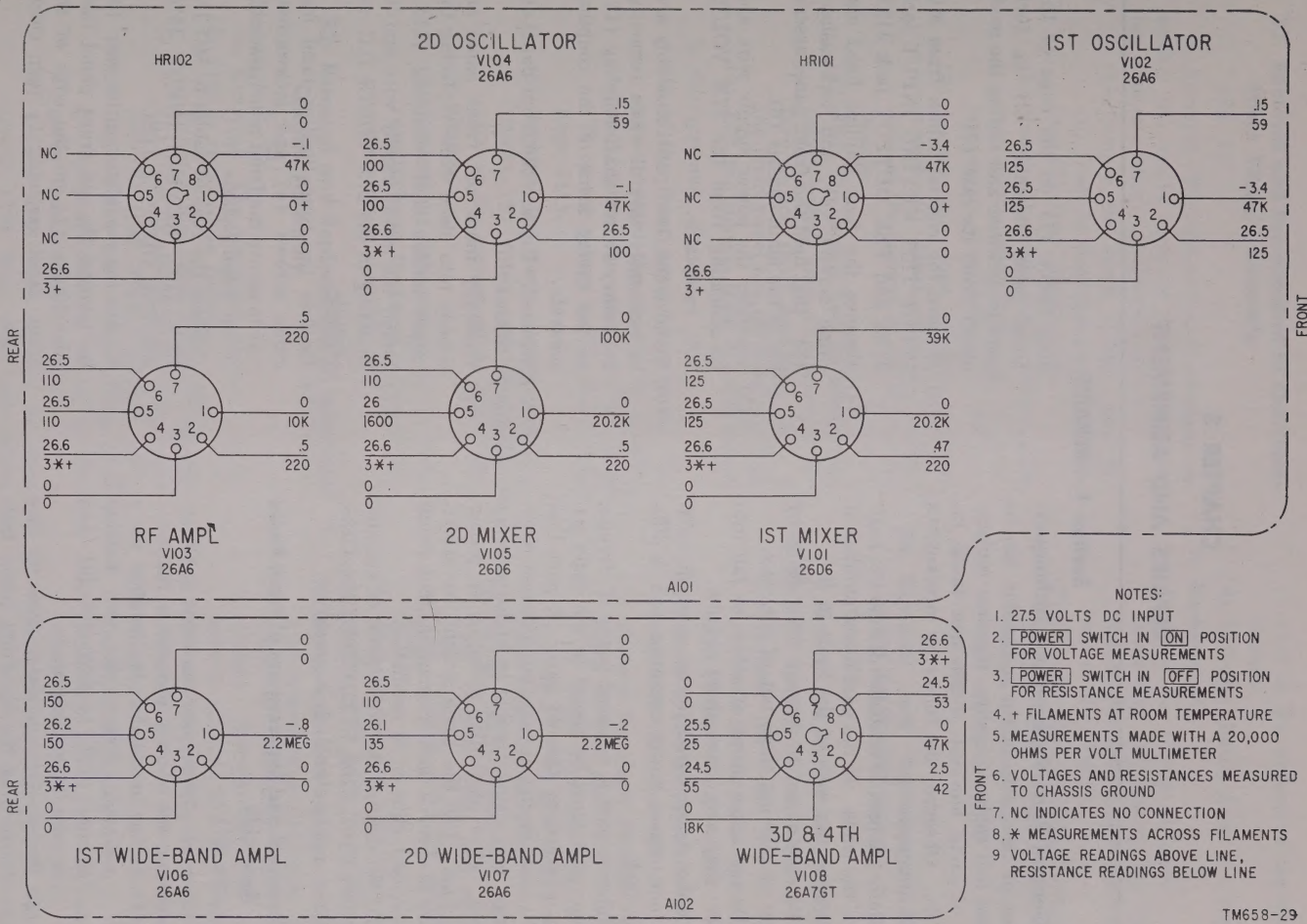


Figure 23. Tube socket voltage and resistance diagram.

CHAPTER 3

REPAIRS AND ALINEMENT

Section I. REPAIRS

30. General Parts Replacement Techniques

Most of the parts in the modulator can be reached and replaced easily. Careless replacement of parts, however, makes new faults inevitable. Observe the following precautions and techniques:

a. Before a part is unsoldered, note the position of the leads. If the part has a number of connections, tag each of the leads to it.

b. Be careful not to damage other leads by pulling or pushing them out of the way.

c. Do not allow drops of solder to fall into the set; they may cause short circuits.

d. Make well-soldered joints; a poorly soldered joint causes faulty operation and is difficult to find.

e. When a part is replaced in the if circuits, the new part must be placed in the exact position occupied by the old part. A part that has the same electrical value but different physical size, may cause trouble in high-frequency circuits. Give particular attention to proper grounding. Use the same ground as before. Failure to observe these precautions may result in decreased gain or in oscillation.

f. Do not disturb the adjustment of variable capacitors C101, C102, C132, C133, C136, C138, and C184 unless absolutely necessary.

31. Removal and Replacement of Front Panel Assembly

(fig. 24)

a. Removal. To remove the front panel assembly from the chassis, proceed as follows:

(1) If the modulator is installed on a mounting, loosen the two holding clamps (TM 11–5820–205–20) and remove the modulator.

(2) Remove the modulator from its case by turning the six front panel fastener knobs (1) on the edge of the front panel assembly (2) ¼ turn counterclockwise and sliding the modulator from its case (3).

(3) Remove the coaxial cables from MO INPUT J105, KEYING INPUT jack J110, and FSK OUTPUT jack J123.

(4) Remove the four Phillips head machine screws (4), and lockwashers (5) that hold the front panel assembly to the main chassis (6).

(5) Unsolder the power supply wire and its shielding from the 27.5 VOLTS D.C. receptacle.

(6) Remove the front panel assembly and be extremely careful while removing the rotary switch shaft coupling (11) as the spring arms of the coupling separate.

b. Replacement. Replace the front panel assembly as follows:

(1) Carefully move the front panel assembly into place while replacing the rotary switch shaft coupling (11).

(2) Solder the power supply wire and its shielding to the 27.5 VOLTS D.C. receptacle.

(3) Replace the four Phillips head machine screws (4) and lockwashers (5) to secure the front panel assembly to the main chassis (6).

(4) Connect the coaxial cables to MO INPUT J105, KEYING INPUT J110, and FSK OUTPUT J123.

(5) Secure the modulator in its case (3) by turning the six front panel fastener knobs (1) on the edge of the front panel assembly ¼ turn clockwise.

32. Removal and Replacement of Oscillator-Mixer Chassis Assembly

(fig. 24)

a. Removal. The oscillator-mixer chassis assembly (8) can be removed from the modulator chassis without unsoldering wires.

(1) Remove the main chassis assembly (6) from its electrical equipment cabinet (3) (par. 31*a*(1)–(6)).

(2) Remove the eight coaxial cables from the receptacles on the top of the oscillator-mixer chassis assembly (8).

(3) Loosen the four captive machine screws (9) fitted with lockwashers (10) at the corners of the top of the chassis.

(4) Slide the chassis back to remove the rotary switch knob (7) from the rotary switch shaft couplings (11) if the front panel has not been removed.

(5) Lift the chassis from the modulator.

b. Replacement.

(1) If the front panel has not been removed, place the chassis in position and replace the rotary switch knob (7) on the rotary switch shaft couplings (11).

(2) Tighten the four captive machine screws (9) fitted with lockwashers (10) at the corners of the top of the chassis.

(3) Connect the eight coaxial cables to the receptables on the top of the oscillator-mixer chassis assembly (8).

33. Removal and Replacement of Amplifier Chassis Assembly

(fig. 24)

a. Removal. The amplifier chassis assembly (12) is removed as follows:

(1) Remove the main chassis assembly (6) from its electrical equipment cabinet (3) (par. 31*a*(1) through (6)).

(2) Remove the four coaxial plugs from the receptacles on the top of the amplifier chassis assembly (12).

(3) Loosen the four captive machine screws (13) fitted with lockwashers (14) at the corners of the top of the chassis.

(4) Lift the chassis from the modulator.

b. Replacement.

(1) Place the chassis in position on the modulator and tighten the four captive screws (13) at the corners of the top of the chassis.

(2) Connect the four coaxial plugs to the receptacles on the top of the amplifier chassis assembly (12). Replace the main chassis assembly (6) (par. 31*a* (1)–(6)).

34. Removal and Replacement of MCS BAND SELECTOR Switch

(fig. 24)

a. Removal. Remove the rotary MCS BAND SELECTOR switch (15) carefully as follows:

(1) Remove the main chassis assembly (6) from its electrical equipment cabinet (3, par. 31*a*(1)–(6)).

(2) Remove the oscillator-mixer chassis assembly (8), (par. 32*a*).

(3) Remove the eight Phillips head machine screws (16) and lockwashers (17) from terminal boards TB110 (18) and TB111 (19), and move them back from the partition.

(4) Loosen the two setscrews (20) in the half coupling (11), and remove the half coupling from the switch (15) shaft.

(5) Remove the nut (21) and the lockwasher (22) from the switch bushing.

(6) Remove the two machine screws (23) and lockwashers (24) that hold the capacitor assembly (25) to the chassis. Remove the four machine screws (26 and 27) and lockwashers (28 and 29) holding the switch mounting plate (30) to the chassis.

(7) Unsolder the wires from the feedthrough capacitator on the switch mounting plate (30). Unsolder the white and green wire that connects between terminal No. 11 on S101 to pin No. 8 of the crystal socket.

(8) Remove the machine screws (31) and lockwashers (32) from the terminal board TB109 (33), and unsolder the white wire connected to the terminal at CR102.

(9) Unsolder the white and red wire from the switch arm (No. 12, of S101, section B rear), to the terminal at R120 on TB109.

(10) Unsolder the sleeve covered wire from the front of section B of switch S101 to J109. Unsolder at J109.

(11) Unsolder the sleeve covered wire from switch S101, section B, rear terminal No. 1, to J111. Unsolder at J111.

(12) Unsolder the sleeve covered wire from switch S101, section A, front, terminal No. 1, to J108. Unsolder at J108.

(13) Push the switch and capacitator assembly back and lift the assembly from the chassis.

(14) Unsolder the eight sleeve covered wires connecting the trimmer capacitors to the front of section C of the switch, and then remove the trimmer capacitor assembly.

(15) Unsolder the fixed capacitor wires from the switch terminals.

(16) Remove the two nuts (34) and lockwashers (35) from the rear of the switch, and remove the switch plate (30).

b. Replacement.

(1) Hold the switch mounting plate (30) and the capacitor assembly (25) mounting strip in the same relative positions as when they are mounted in the subchassis.

(2) Assemble the switch mounting plate (30) and the rotary switch (15) and fasten them together with the two lockwashers (35) and hexagonal nuts (34).

(3) Solder the wires from the fixed capacitors on their respective switch lugs.

(4) Position the trimmer capacitor assembly and solder the eight wires from the capacitors on their respective solder lugs on the switch.

(5) Remove the assembly from the fixture and slide it into place in the oscillator-mixer chassis assembly (8).

(6) Solder the sleeve-covered wire from switch S101, section A front, terminal No. 1, to J108.

(7) Solder the sleeve-covered wire from switch S101, section B rear, terminal No. 1, to J111.

(8) Solder the sleeve-covered wire from switch S101, section B front, to J109.

(9) Solder the white wire to the terminal at CR102.

(10) Assemble terminal board TB109 (33) to the oscillator-mixer chassis assembly (8) with the Phillips head machine screws (31) and lockwashers (32).

(11) Solder the white and green wire that goes from terminal No. 11 on S101 to pin No. 8 of the crystal socket XHR-101.

(12) Solder the wires on the feedthrough capacitor on the switch mounting plate (30).

(13) Secure the switch mounting plate (30) to the oscillator-mixer chassis assembly (8) with the four Phillips head machine screws (26 and 27) and lockwashers (28 and 29). Secure the capacitor assembly (25) to the oscillator-mixer chassis assembly (8) with the two Phillips head machine screws (23) and lockwashers (24).

(14) Fasten the rotary switch (15) to the chassis (8) with the lockwasher (22) and hexagonal nut (21).

(15) Position terminal boards TB110 (18) and TB111 (19), and fasten them to the chassis (8) with eight Phillips head machine screws (16) and lockwashers (17).

(16) Place the rotary switch shaft coupling (11) on the switch shaft, and index the coupling on the shaft so

that the switch positions agree with the numbers at the pointer.

(17) Install the oscillator-mixer chassis assembly (8) in the modulator.

35. Removal and Replacement of Low-Pass Filter FL101

(fig. 24)

a. Removal. Remove dual low-pass filter FL101 (36) as outlined below.

(1) Loosen the six fastener front panel knobs (1) and slide the main chassis assembly (6) from its electrical equipment cabinet (3).

(2) Remove P105, P106, and P107, respectively (fig. 22).

(3) Loosen the four captive screws (37, fig. 24) and remove the filter.

b. Replacement.

(1) Place the filter in position and tighten the four captive screws (37, fig. 24).

(2) Connect P105, P106, and P107, respectively (fig. 22).

(3) Slide the main chassis assembly (6) into its electrical equipment cabinet (3) and fasten the six front panel knobs (1).

36. Removal and Replacement of Low-Pass Filter FL102

(fig. 24)

a. Removal. Remove the low-pass filter F102 (39) as outlined below.

(1) Loosen the six front panel knobs (1) and slide the main chassis assembly (6) from its electrical equipment cabinet (3).

(2) Remove P118 and P119 from J118 and J119, respectively (fig. 22).

(3) Loosen the four captive screws (40, fig. 24) and remove the filter.

b. Replacement.

(1) Place the filter in position and tighten the four captive screws (40, fig. 24).

(2) Connect P118 and P119 to J118 and J119, respectively (fig. 22).

(3) Slide the main chassis assembly (6) into its electrical equipment cabinet (3) and tighten the six front panel knobs (1).

37. Removal and Replacement of Band-Pass Filter FL103

(fig. 24)

a. Removal. Remove band-pass filter FI103 (42) as follows:

(1) Loosen the six front panel knob fasteners (1) and slide the main chassis assembly (6) from its electrical equipment cabinet (3).

(2) Remove P113 and P114 from J113 and J114, respectively (fig. 22).

(3) Loosen the six captive screws (43, fig. 24) and remove the filter.

b. Replacement.

(1) Place the filter in position and tighten the six captive screws (43, fig. 24).

(2) Connect P113 and P114 to J113 and J114, respectively (fig. 22).

(3) Slide the main chassis assembly (6) into its electrical equipment cabinet (3) and tighten the six front panel knob fasteners (1).

Section II. ALINEMENT

38. Test Equipment and Special Tools Required for Alinement

The following test equipment and special tools are required for alinement of Radio Transmitter Modulator MD–203/GR:

Item	Technical manual	Common name
Electronic Multimeter TS–505/U	TM 11–5511	Multimeter
RF Signal Generator AN/URM–25	TM 11–5551	Signal generator
Frequency Meter AN/USM–26 (4th and 5th echelons only)	TM 11–5057	Frequency Meter AN/USM–26
Radio Transmitter T–195/GRC–19	TM 11–806	Radio transmitter
Frequency Meter AN/USM–32	TM 11–5120	Frequency Meter

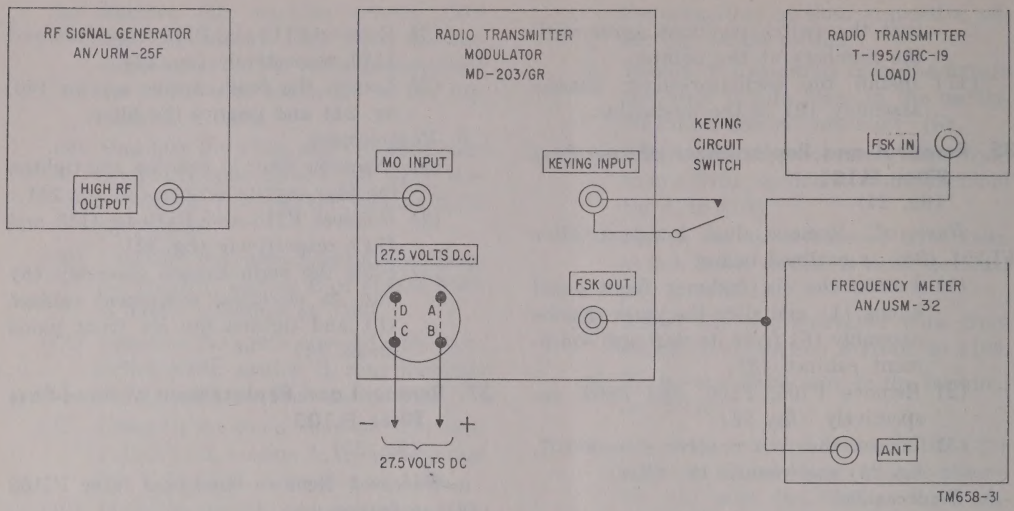


Figure 25. Test setup for alinement.

39. Oscillator Plate Tuning

Remove the modulator chassis from the case (par. 31*a*(2)). The slotted adjusting screws are accessible on the tops of the Z102 and Z104 assemblies.

a. Connections. Connect the equipment as shown (fig. 25). The power supply voltage should be adjusted for 27.5 volts, dc input to the modulator. Hold the probe of the multimeter on test point TP101 or TP102 (fig. 19) as required. Set the signal generator frequency to correspond to the modulator MCS BAND SELECTOR switch setting. Connect an on-off toggle switch to short a connector plug which fits the KEYING INPUT receptacle. Connect this shorting switch circuit to the KEYING INPUT receptacle, and turn the shorting switch on.

b. Preliminary Adjustments (fig. 26).

(1) Turn the slotted adjusting screws on Z102 and Z104 fully counterclockwise.

(2) Turn the adjustments of C132, C133, C136, C138, and C184 to a position near the middle of their ranges, if these adjustments have been moved from their correct positions.

(3) Turn the equipment on and allow at least 10 minutes warmup.

c. Tank Circuit Z102 Adjustment.

(1) Connect the dc probe of the multimeter to test point TP101 near V101 (negative polarity).

(2) Turn the slotted screw on Z102 clockwise until the multimeter indicates a peak. Record this peak voltage and calculate 70 percent of it.

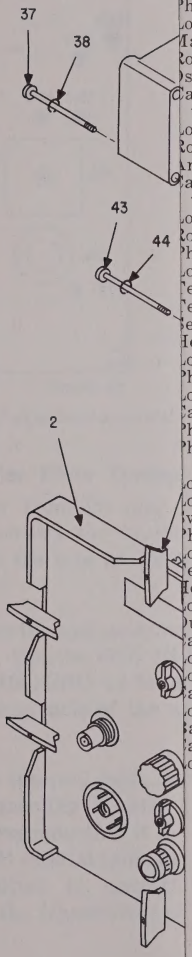
(3) Continue to turn the slotted screw clockwise until the multimeter indicates the value which is 70 percent of the peak reading. Tank circuit Z102 is now properly adjusted.

d. Tank Circuit Z104 Adjustment.

(1) Connect the dc probe of the multimeter to test point TP102 near V105 (negative polarity).

(2) Turn the slotted screw on Z104 clockwise until the multimeter indicates a peak reading. Record this reading and calculate 70 percent of it.

(3) Continue to turn the slotted screw clockwise until the multimeter indicates the value which is 70 percent of the recorded peak reading. Tank circuit Z104 is now properly adjusted.



Front panel fastener knobs, MP117 through MP122
Front panel assembly
Electrical equipment cabinet, A 113
Phillips head machine screw, 10-32, 5/8 inch long
Lockwasher, No. 10
Main chassis assembly
Rotary switch knob, S102
Oscillator-mixer chassis assembly, A 101
Captive machine screw, No. 10-32 NC-2A, H123 through H126
Lockwasher, No. 10
Rotary switch shaft coupling, HP155
Amplifier chassis assembly, A 102
Captive machine screw, No. 10-32 NC-2A, H 127 through H130
Lockwasher, No. 10
Rotary switch, S101
Phillips head machine screw, No. 6-32, 1/4 inch long
Lockwasher, No. 6
Terminal board, TB110
Terminal board, TB111
Setscrew
Hexagonal nut, No. 3/8-32-NF
Lockwasher, 3/8 inch
Phillips head machine screw, No. 6-32, 1/4 inch long
Lockwasher, No. 6
Capacitor assembly
Phillips head machine screw, No. 6-32, 1/4 inch long
Phillips head machine screw, No. 4-40, 5/16 inch long
Lockwasher, No. 6
Lockwasher, No. 4
Switch mounting plate
Phillips head machine screw, No. 6-32, 1/4 inch long
Lockwasher, No. 6
Terminal board, TB109
Hexagonal nut, No. 4-40
Lockwasher, No. 4
Dual low-pass filter, FL101
Captive screw, No. 8-32, H101 through H104
Lockwasher, No. 8
Low-pass filter, FL102
Captive screw, No. 8-32, H105 through H108
Lockwasher, No. 8
Band-pass filter, FL103
Captive screw, No. 8-32, H109 through H114
Lockwasher, No. 8

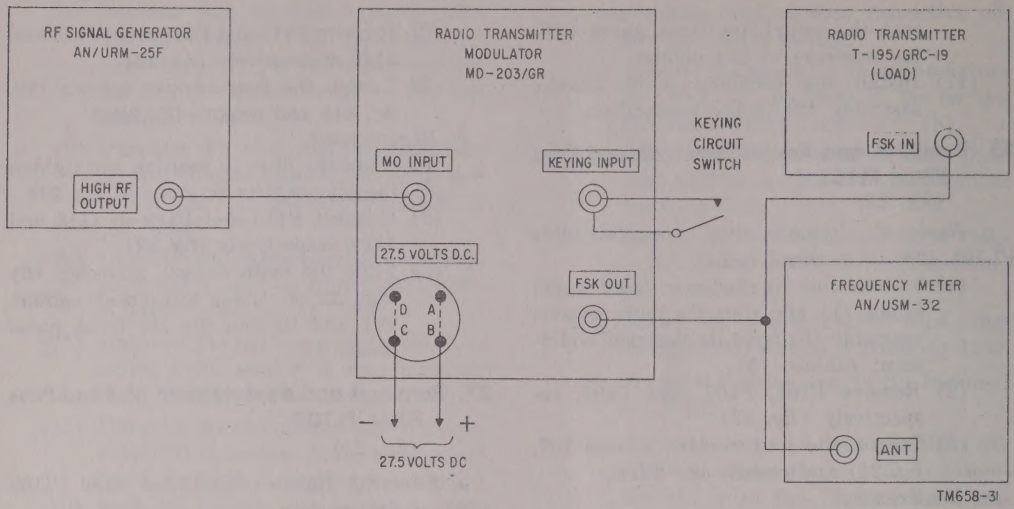


Figure 25. Test setup for alinement.

39. Oscillator Plate Tuning

Remove the modulator chassis from the case (par. 31*a*(2)). The slotted adjusting screws are accessible on the tops of the Z102 and Z104 assemblies.

a. Connections. Connect the equipment as shown (fig. 25). The power supply voltage should be adjusted for 27.5 volts, dc input to the modulator. Hold the probe of the multimeter on test point TP101 or TP102 (fig. 19) as required. Set the signal generator frequency to correspond to the modulator MCS BAND SELECTOR switch setting. Connect an on-off toggle switch to short a connector plug which fits the KEYING INPUT receptacle. Connect this shorting switch circuit to the KEYING INPUT receptacle, and turn the shorting switch on.

b. Preliminary Adjustments (fig. 26).

(1) Turn the slotted adjusting screws on Z102 and Z104 fully counterclockwise.

(2) Turn the adjustments of C132, C133, C136, C138, and C184 to a position near the middle of their ranges, if these adjustments have been moved from their correct positions.

(3) Turn the equipment on and allow at least 10 minutes warmup.

c. Tank Circuit Z102 Adjustment.

(1) Connect the dc probe of the multimeter to test point TP101 near V101 (negative polarity).

(2) Turn the slotted screw on Z102 clockwise until the multimeter indicates a peak. Record this peak voltage and calculate 70 percent of it.

(3) Continue to turn the slotted screw clockwise until the multimeter indicates the value which is 70 percent of the peak reading. Tank circuit Z102 is now properly adjusted.

d. Tank Circuit Z104 Adjustment.

(1) Connect the dc probe of the multimeter to test point TP102 near V105 (negative polarity).

(2) Turn the slotted screw on Z104 clockwise until the multimeter indicates a peak reading. Record this reading and calculate 70 percent of it.

(3) Continue to turn the slotted screw clockwise until the multimeter indicates the value which is 70 percent of the recorded peak reading. Tank circuit Z104 is now properly adjusted.

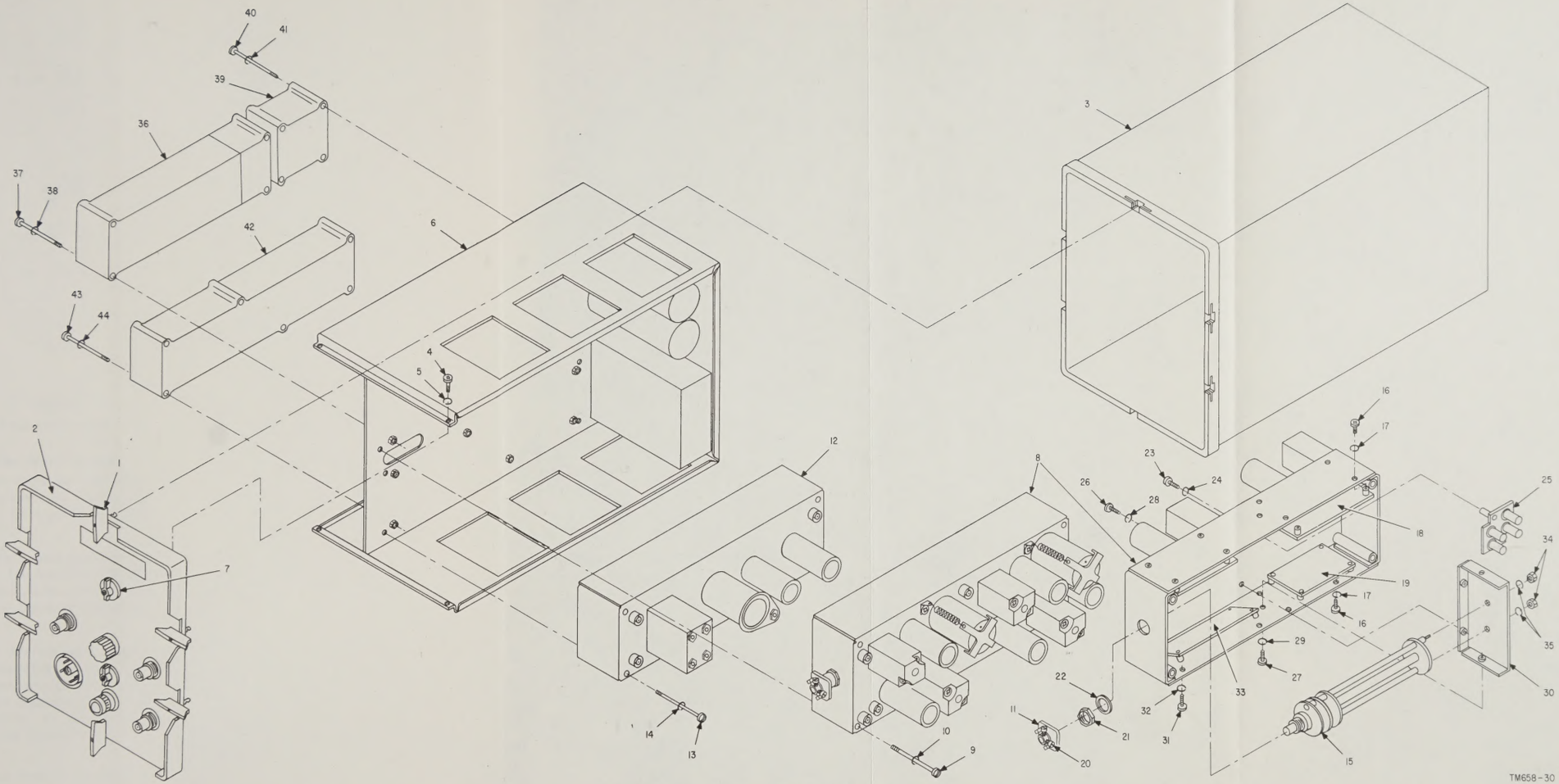
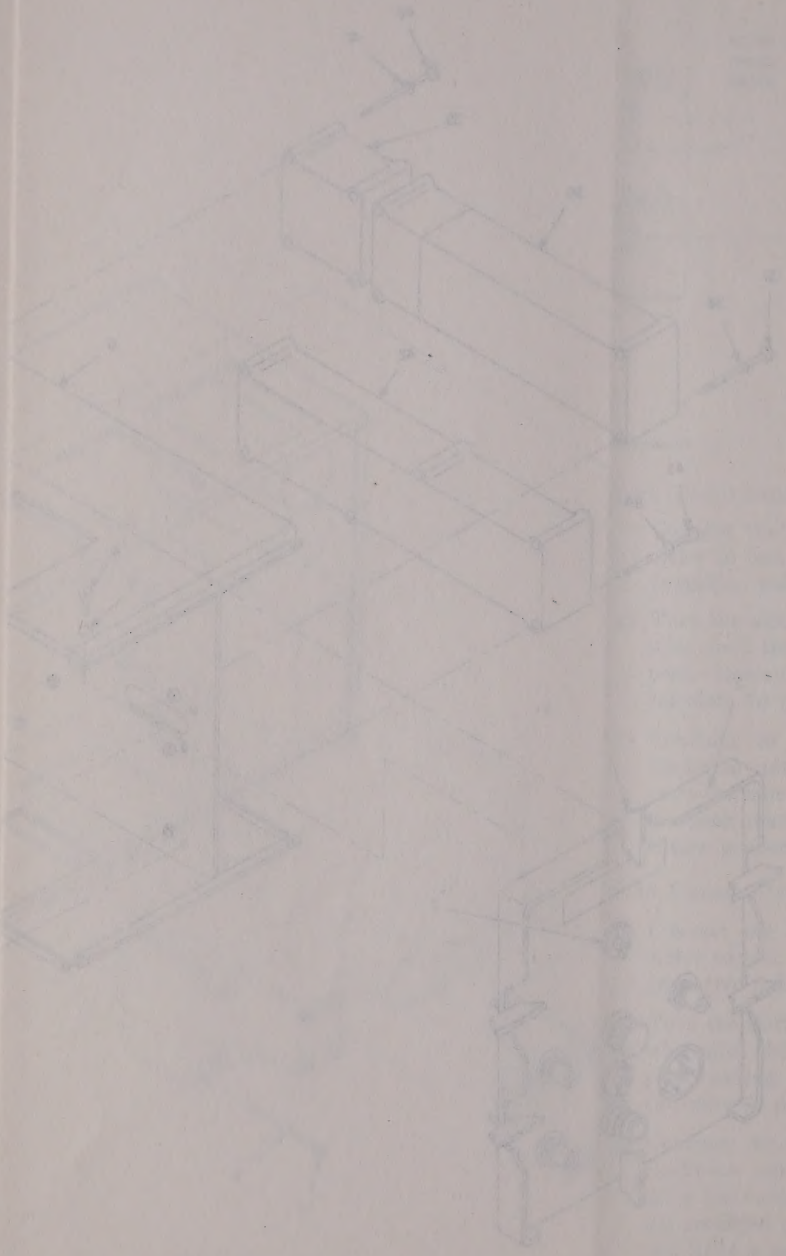


Figure 24. Radio Transmitter Modulator MD–203/GR, exploded view.

1 Front panel fastener knobs, MP117 through MP122
2 Front panel assembly
3 Electrical equipment cabinet, A 113
4 Phillips head machine screw, 10-32, ⅝ inch long
5 Lockwasher, No. 10
6 Main chassis assembly
7 Rotary switch knob, S102
8 Oscillator-mixer chassis assembly, A 101
9 Captive machine screw, No. 10-32 NC-2A, H123 through H126
10 Lockwasher, No. 10
11 Rotary switch shaft coupling, HP155
12 Amplifier chassis assembly, A 102
13 Captive machine screw, No. 10-32 NC-2A, H 127 through H130
14 Lockwasher, No. 10
15 Rotary switch, S101
16 Phillips head machine screw, No. 6-32, ¼ inch long
17 Lockwasher, No. 6
18 Terminal board, TB110
19 Terminal board, TB111
20 Setscrew
21 Hexagonal nut, No. ⅜-32-NF
22 Lockwasher, ⅜ inch
23 Phillips head machine screw, No. 6-32, ¼ inch long
24 Lockwasher, No. 6
25 Capacitor assembly
26 Phillips head machine screw, No. 6-32, ¼ inch long
27 Phillips head machine screw, No. 4-40, 5/16 inch long
28 Lockwasher, No. 6
29 Lockwasher, No. 4
30 Switch mounting plate
31 Phillips head machine screw, No. 6-32, ¼ inch long
32 Lockwasher, No. 6
33 Terminal board, TB109
34 Hexagonal nut, No. 4-40
35 Lockwasher, No. 4
36 Dual low-pass filter, FL101
37 Captive screw, No. 8-32, H101 through H104
38 Lockwasher, No. 8
39 Low-pass filter, FL102
40 Captive screw, No. 8-32, H105 through H108
41 Lockwasher, No. 8
42 Band-pass filter, FL103
43 Captive screw, No. 8-32, H109 through H114
44 Lockwasher, No. 8



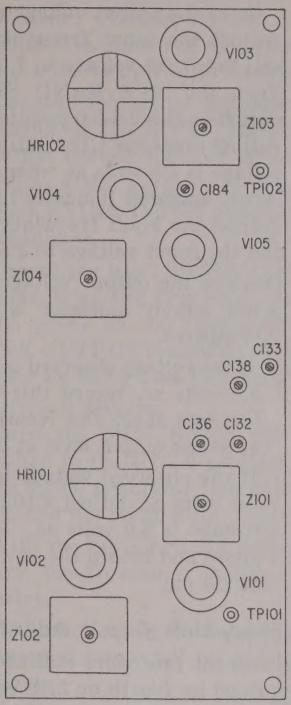


Figure 26. Location of alinement controls.

40. Mixer and Amplifier Plate Tuning

Remove the modulator from its case (par. 31*a*(2)). The slotted screws for tuning the circuits are accessible on the tops of Z101 and Z103.

a. Connections. Connect the test equipment to the modulator (fig. 27). Use the FSK IN jack of Radio Transmitter T–195/GRC–19 for a load on the FSK OUTPUT receptacle of the modulator.

(1) Change the two internal cable connections by disconnecting coaxial cable from J101 and reconnecting it to J620 and connect P601 coaxial cable to J101 of the transmitter to connect the modulator into the transmitter circuit (TM 11–806).

(2) Inject the output from the signal generator to the MO INPUT receptacle of the modulator, with the output connecting cord W102.

(3) Use the multimeter to measure the voltage output of the signal generator. The output voltage of the modulator is read on the ac voltmeter connected to the FSK OUTPUT receptacle. Use T-connectors in the input and output circuits to connect the probe of the multimeter. The power supply voltage should be 27.5 volts dc. Allow the equipment to warm up for at least 10 minutes.

(4) Connect a keying circuit switch (par. 42*a*) to the KEYING INPUT receptacle for closing the circuit.

b. Tank Circuit Z101 Adjustment.

(1) Adjust the input frequency to 1.5 mc and the input level to 2 volts, ac.

(2) Close the keying circuit switch. Set the MCS BAND SELECTOR switch to the 1.5-1.7 position.

(3) Turn the slotted adjusting screw on Z101 until the multimeter indicates a peak. Tank circuit Z101 is now properly adjusted.

c. Tank Circuit Z103 Adjustment.

(1) Adjust the input frequency to 3 mc and the input level to 1 volt ac.

(2) Close the keying circuit switch. Set the MCS BAND SELECTOR switch to the 2.4-3.0 position.

(3) Turn the slotted adjusting screw on Z103 until the multimeter indicates a peak. Tank circuit Z103 is now properly adjusted.

41. Output Level Adjustment

The output level of Radio Transmitter Modulator MD–203/GR can be varied by adjustment of C101 and C102 (fig. 22). Capacitor C101 controls the level through the 3.4-mc part of dual low-pass filter FL101 and capacitor C102 controls the level through the 3.4-mc part of dual low-pass filter FL101. The output level of the modulator is normally adjusted for the proper operation of Radio Transmitter T–195/GRC–19. Remove the modulator from its case (par. 31*a*(2)). Capacitors C101 and C102 adjustments are on the band-pass filter assembly FL103 under the chassis (fig. 22).

a. Connections. Connect the test equipment to the modulator as shown in figure 27. Use the FSK IN jack of Radio Transmitter T–195/GRC–19 for a load on the FSK OUTPUT receptacle of the modulator.

(1) Change the two internal cable connections of the transmitter (par. 40 *a*(1)) to connect the modulator into the transmitter circuit (TM 11–806).

(2) Connect the output of the signal generator to the MO INPUT receptacle of the modulator with output connecting cord W102.

(3) Use the multimeter to measure the voltage output of the signal generator. The ac output voltage is read on the multimeter connected to the FSK OUTPUT receptacle. Use T-connectors in the input and output circuits to connect the test units. The power supply voltage should be maintained at 27.5 ±.2 volts dc.

(4) Allow the equipment to warm up for at least 10 minutes. Keep the keying circuit switch closed.

b. Procedure.

(1) Adjust the input frequency to 1.5 mc and the input voltage to 1.93 volts ac, as read on the multimeter. Turn the MCS BAND SELECTOR switch to the 1.5-1.7 position.

(2) Adjust capacitor C101 until the output voltage is 4 volts ac when the power supply ammeter indicates 1.9 amperes.

(3) Adjust the input frequency to 2.25 mc and the input voltage to 1.45 volts ac.

(4) Observe the output voltage when the power supply ammeter indicates 1.9 amperes.

(*a*) If the voltage observed is more than 3.5 volts ac, record the observed voltage and record 4 volts ac as the output level at 1.5 mc.

(*b*) If the observed voltage is less than 3.5 volts ac, adjust C101 so that this voltage is 3.5 volts ac. Repeat (3) above and record the output voltage at 1.5 mc. Record 3.5 volts ac as the output voltage at 2.25 mc.

(5) Adjust the input frequency to 3 mc and the input voltage to 1.01 volts ac. Turn the MCS BAND SELECTOR switch to the 2.4-3.0 position.

(6) Adjust capacitor C102 until the output voltage is 3.5 volts ac when the power supply ammeter indicates 1.9 amperes.

(7) Adjust the input frequency to 2.0 mc and the input voltage to 1.53 volts ac.

(8) Observe the output voltage while the power supply ammeter is indicating 1.9 amperes.

(*a*) If the voltage observed is more than 5.0 volts ac, record this voltage on the data sheet and record 3.5 volts ac as the output level at 3.0 mc.

(*b*) If the observed voltage is less than 5.0 volts ac, adjust C102 until this voltage is 5.0 volts ac. Repeat (5) above and record the output voltage at 2.0 mc.

42. Frequency-Shift Circuit Adjustment

The adjustment procedure outlined below, is to be performed by fourth or fifth echelon personnel. With the keying circuit closed, the frequency at the output of the modulator is the same as the frequency at the input, with the MCS BAND SELECTOR switch in any position. With the keying circuit opened, the frequency is shifted to a lower value. The amount depends on the setting of the MCS BAND SELECTOR switch (par. 7). Frequency Meter AN/USM–26 is used to measure the two frequencies and the frequency shift is the difference between them. Allow the signal generator to warmup (15 to 30 minutes) for good frequency stability for this adjustment. The frequency of the second oscillator does not have to be set the same as the frequency of the first oscillator for the frequency-shift circuit adjustment but should be within several hundred cycles. The following adjustments will be easier to make if the heater of the second oven is not working and causing a variation in current drain. Remove the heater wire of HR102 from the socket terminal 3 to prevent the oven from operating.

a. Connections. Connect the test equipment to the modulator as shown in figure 29, and let the equipment warm up for 20 minutes.

(1) Connect the signal generator to the modulator MO INPUT receptacle with output connecting cord W102.

(2) Connect the keying circuit switch to the KEYING INPUT receptacle of the modulator.

(3) Conect the load, SIGNAL INPUT receptacle of the frequency meter, and the probe of the multimeter to the FSK OUTPUT receptacle of the modulator by using two T-connectors.

b. Adjustment, 850-cps.

(1) Turn the MCS BAND SELECTOR switch to the 1.7-2.0 position. Adjust the signal generator frequency for 2.0 mc and the voltage for 1.5 volts ac.

(2) With the keying circuit switch closed, note the frequency on the frequency meter.

(3) With the keying circuit switch open, note the frequency on the frequency meter.

(4) Subtract the frequencies.

(5) If the difference is more than the required shift, adjust C138 counterclockwise.

(6) If the difference is less than the required shift, adjust C138 clockwise.

(7) While alternately opening and closing the keying circuit switch, adjust C138 until the frequency counted with the keying circuit open minus the frequency counted with the keying circuit closed equals 850 cps.

(8) With the keying circuit switch closed, wait for the frequency meter to indicate two successive identical counts and note the frequency. Quickly open the keying circuit switch and note the frequency.

Note. The opening and closing of the keying circuit switch must occur while the gate lamp on the frequency meter is off. The display time control of the frequency meter must be set at the minimum time required to observe the display.

(9) The frequency difference with the keying circuit switch opened and closed must be 850 ±8 cps. Repeat (7) and (8) above if the shift is out of limits.

c. Adjustment, 425-cps.

(1) Turn the MCS BAND SELECTOR switch to the 4-6 position.

(2) While alternately closing and opening the keying circuit switch, adjust C133 until the frequency counted with the keying circuit open minus the frequency counted with the keying circuit closed is 425 cps.

(3) With the keying circuit switch closed, wait for the frequency meter to indicate two successive identical counts, and note the frequency. Quickly open the keying circuit switch and note the frequency.

Note. The opening and closing of the keying circuit switch must occur while the gate lamp on the frequency meter is off.

(4) The frequency counted with the keying circuit switch open minus the frequency counted with the keying circuit switch closed must be 425 ±4 cps. Repeat (2) above if the frequency shift is out of limits.

d. Adjustment, 212 CPS.

(1) Turn the MCS BAND SELECTOR switch to the 6-9 position.

(2) While alternately closing and opening the keying circuit switch, adjust C132 until the frequency counted with the keying circuit open minus the frequency counted with the keying circuit closed is 212 cps.

(3) With the keying circuit switch closed, wait for the frequency meter to indicate two successive identical counts, and note the frequency. Quickly open the keying circuit switch and note the frequency.

Note. The closing and opening of the keying circuit switch must occur while the gate lamp on the frequency meter is off.

(4) The frequency counted with the keying circuit switch opens minus the frequency with the keying circuit switch closed must be 212 ±2 cps. Repeat (2) above if the frequency shift is out of limits.

e. Adjustment, 106 CPS.

(1) Turn the MCS BAND SELECTOR switch to the 16-20 position.

(2) While alternately closing and opening the keying circuit switch, adjust C136 until the frequency counted with the keying circuit open minus the frequency counted with the keying circuit closed is 106 cps.

(3) With the keying circuit switch closed, wait for the frequency meter to indicate two successive identical counts, and note the frequency. Quickly open the keying circuit switch and note the frequency.

Note. The closing and opening of the keying circuit switch must occur while the gate lamp on the frequency meter is off.

(4) The frequency counted with the keying circuit switch open minus the frequency with the keying circuit switch closed must be 106 ±1 cps. Repeat (2) above if the frequency shift is out of limits.

43. Second Oscillator Frequency Adjustment

The adjustment procedure outlined below, is to be performed by fourth or fifth echelon personnel. Trimmer capacitor C184 provides a means for adjusting the frequency of the second oscillator to the exact same frequency of the first oscillator, when the keying circuit switch is closed. The frequency-shift circuit adjustment (par. 42) affects the frequency of the first oscillator. The frequency of the second oscillator should be adjusted after the frequency-shift circuit is adjusted.

a. Connections. Connect the test equipment to the modulator as shown in figure 29. The signal generator is connected to the modulator MO INPUT receptacle with output connecting cord W102. The keying circuit switch is connected to the KEYING INPUT receptacle of the modulator. The load, SIGNAL INPUT receptacle of the frequency meter, and the probe of the multimeter are connected to the FSK OUTPUT receptacle of the modulator.

b. Preliminary Procedure.

(1) If the heater wire at terminal 3 of the HR102 crystal oven was removed for the frequency-shift circuit adjustment (par. 42), resolder it to the terminal.

(2) Let the equipment warm up for 20 minutes.

c. Procedure.

(1) Turn the MCS BAND SELECTOR switch to the 12-16 position.

(2) Adjust the signal generator for a frequency of 2.0 mc and an output of 1.5 volts ac.

(3) Turn the C184 adjusting screw fully counterclockwise.

Note. Keep the keying circuit switch closed for the following tests.

(4) Turn the C184 adjusting screw clockwise until the counter indicates that the output frequency is the same as the input frequency. The input and output frequencies should be the same, however there is a maximum tolerance of 20 cps for the frequency difference if they are not the same.

(5) Turn the MCS BAND SELECTOR switch to the 9-12 position. The maximum tolerance is 40 cps for the difference between the input and output frequencies.

(6) If the frequency difference is outside or close to the maximum tolerance, readjust C184 so that the percentage deviation will be the same, with the MCS BAND SELECTOR switch in the 9-12 and 12-16 positions.

(7) Turn the MCS BAND SELECTOR switch to the 3-4 position. The maximum tolerance is 70 cps for the difference between the input and output frequencies.

(8) Turn the MCS BAND SELECTOR switch to the 2.4-3.0 position. The maximum tolerance is 95 cps for the difference between the input and output frequencies.

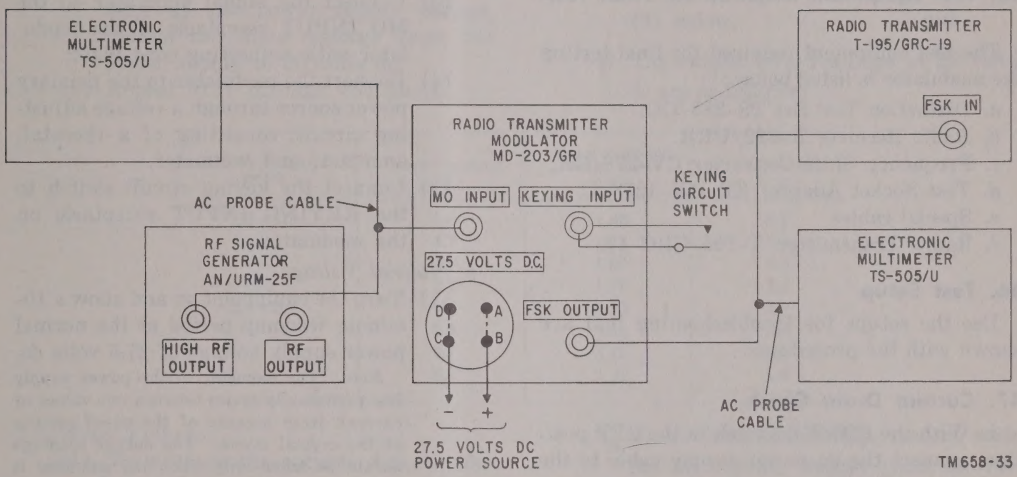


Figure 27. Setup for mixer and amplifier plate alinement.

CHAPTER 4

FINAL TESTING

44. Purpose of Final Testing

The tests outlined in this chapter are designed to measure the performance capability of a repaired modulator. A repaired modulator that meets the minimum standards stated in the tests will furnish satisfactory operation, equivalent to that of a new modulator.

45. Test Equipment Required for Final Testing

The test equipment required for final testing the modulator is listed below:

a. Distortion Test Set TS–383/GG.
b. Radio Receiver R–392/URR.
c. Frequency Shift Converter CV–278/GR.
d. Test Socket Adapter Kit MX–1258/U.
e. Special cables.
f. Radio Transmitter T–195/GRC–19.

46. Test Setup

Use the setups for troubleshooting that are shown with the procedures.

47. Current Drain Check

a. With the POWER switch in the OFF position, connect the dc power supply cable to the modulator. Decrease the power supply output to zero and turn the modulator on.

b. Gradually increase the power supply output to 30 volts, and at the same time, observe the current drawn on an ammeter. The tubes should light and the current drawn by the modulator should not be more than 1.8 amperes at 30 volts.

48. Output Level Test

The output level of the modulator is measured with the MCS BAND SELECTOR switch in certain positions, with specified values of signal input, and at certain frequencies. The output level readings are given for normal, low, and high primary power voltages.

a. Connections. Connect the test equipment to the modulator as shown in figure 27.

(1) Connect the radio transmitter to the FSK OUTPUT receptacle of the modulator with a T-connector.
(2) Connect the probe of the multimeter to the output circuit at the T-connector.
(3) Connect the signal generator to the MO INPUT receptacle of the modulator with connecting cord W102.
(4) Connect the modulator to the primary power source through a voltage adjusting circuit, consisting of a rheostat, ammeter, and voltmeter.
(5) Connect the keying circuit switch to the KEYING INPUT receptacle on the modulator.

b. Normal Voltage.

(1) Turn the equipment on and allow a 10-minute warmup period at the normal power supply voltage of 27.5 volts dc.

Note. The ammeter in the power supply line periodically cycles between two values of current drain because of the on-off cycling of the crystal ovens. The output readings should be taken only when the ammeter is indicating the highest reading.

(2) Turn the MCS BAND SELECTOR switch to the position indicated in the chart below.
(3) Adjust the frequency of the signal generator to the frequency indicated. Adjust the voltage of the generator to 1.93 volts ac.
(4) When the dc power supply voltmeter and ammeter indicate the proper values as specified, read the output voltage of the modulator. The low and high limits for the output readings are given in the chart in (6) below.
(5) Repeat (2) through (4) above with the MCS BAND SELECTOR switch

set in the position shown and with the frequency listed in the chart in (6) below.

(6) The output level markings at 27.5 volts dc are as follows:

MCS BAND SELECTOR switch	Input frequency (mc)	Signal generator output volts (ac)	Low limit (v ac)	High limit (v ac)
1.5 - 1.7	1.5	1.93	3.2	10
	1.7	1.75	3.4	12
	2.0	1.53	3.7	12
	2.25	1.38	2.8	10
2.0 - 2.4	2.0	1.53	4.0	12
	2.3	1.35	4.5	12
	2.7	1.15	2.8	12
	3.0	1.01	2.6	10

c. Low Voltage.

(1) To measure the output of the modulator at low power supply voltage, change the input voltage from the power supply to 26 volts dc.

(2) Repeat *b*(2) through (5) above.

(3) Check the output voltage readings with the low power supply chart in (4) below.

(4) The output level readings at 26 volts dc are as follows:

MCS BAND SELECTOR switch	Input frequency (mc)	Signal generator output volts (ac)	Low limit (v ac)
1.5 - 1.7	1.5	1.93	3.2
	1.7	1.75	2.4
	2.0	1.53	2.6
	2.25	1.38	2.0
2.0 - 2.4	2.0	1.53	2.8
	2.3	1.35	3.2
	2.7	1.15	2.0
	3.0	1.01	1.8

d. High Voltage.

(1) To measure the output of the modulator at high power supply voltage, change the input voltage from the power supply to 30 volts dc.

(2) Repeat *b*(2) through (5) above.

(3) Check the output voltage reading with the high power supply chart in (4) below.

(4) The output level readings at 30 volts dc are as follows:

MCS BAND SELECTOR switch	Input frequency (mc)	Signal generator output volts (ac)	Low limit (v ac)
1.5 - 1.7	1.5	1.93	12
	1.7	1.75	14
	2.0	1.53	14
	2.25	1.38	12
2.0 - 2.4	2.0	1.53	14
	2.3	1.35	14
	2.7	1.15	14
	3.0	1.01	12

49. Frequency Shift Keying Test

The frequency shift keying of the modulator is measured without removing the case. The equipment must be given a warmup period of approximately 20 minutes.

a. Connections. Connect the test equipment to the modulator as shown in figure 29, and described below.

(1) Connect the signal generator to the MO INPUT receptacle of the modulator. Use connecting cord W102.

(2) Measure the output voltage with the multimeter.

(3) Connect the keying circuit (par. 42*a*) to the KEYING INPUT receptacle of the modulator.

(4) Connect the radio transmitter and the SIGNAL INPUT receptacle of the frequency meter to the FSK OUTPUT receptacle of the modulator.

(5) Disconnect the crystal oven heater wire at terminal 3 of HR102.

b. Initial Adjustments.

(1) Place the MCS BAND SELECTOR switch in the 16-20 position.

(2) Adjust the signal generator for a frequency of 2.0 mc and an output voltage of 1.5 volts ac.

(3) Close the keying circuit switch.

(4) Turn C184 fully counterclockwise, then clockwise until counter (frequency meter) indicates a difference frequency of approximately 100 cps.

c. Procedure.

(1) Adjust the frequency meter RF mixer output level and counter sensitivity so that the counter gives consistent indications of the difference frequency.

(2) Observe that the difference frequency indicated on counter slowly varies. When the counter repeats the same count twice in succession (record this count), quickly open the keying switch and record the first count displayed.

Caution: **The keying switch must be thrown to open position during short interval that frequency meter "gate" light on counter is off.**

(3) Close keying switch and record first count displayed on scrap paper.

(4) Perform subtractions to verify that the difference between the two counts obtained above (*c*(2) and (3)) is within one cycle. If they are not within one cycle, repeat entire procedure.

(5) Repeat (1) through (4) above MCS BAND SELECTOR switch positions 4-6, 6-9, and 16-20.

(6) Solder the crystal oven heater wire to terminal 3 of HR102.

(7) Place MCS BAND SELECTOR switch in the 16-20 position.

(8) Close the keying switch and turn C184 fully counterclockwise, then clockwise. Counter (of frequency meter) should indicate a difference frequency of zero. If the difference frequency is not zero, a defective crystal oven is indicated.

50. Frequency Tolerance Test

a. Connect the test equipment (fig. 29), and let the equipment warm up for 20 minutes.

b. Set the frequency of the signal generator to 2.0 mcs, and make the tests at each position of the MCS BAND SELECTOR switch, as listed in the chart *d* below, with the keying switch closed. The signal generator frequency must not drift. Use 27.5 volts dc input.

c. Check the signal input frequency against the output frequency with the frequency meter.

d. The frequency tolerance test readings should be as follows:

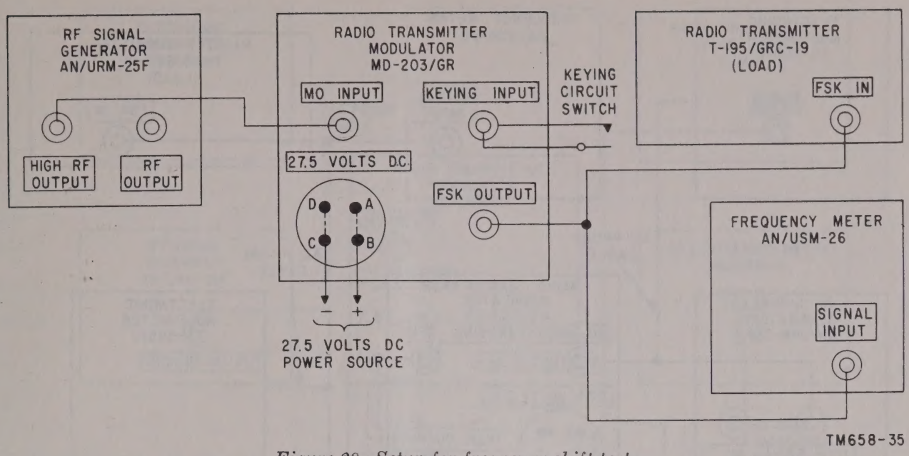


Figure 28. Setup for frequency-shift test.

MCS BAND SELECTOR switch position	Input frequency (mc)	Input signal level (volts)	Frequency tolerance limits *
1.7 - 1.5	2.0	1.5	±100
2.0 - 1.7	2.0	1.5	±100
2.4 - 2.0	2.0	1.5	±100
3.0 - 2.4	2.0	1.5	±100
4 - 3	2.0	1.5	±75
4 - 6	2.0	1.5	±75
6 - 9	2.0	1.5	±50
9 - 12	2.0	1.5	±50
12 - 16	2.0	1.5	±25
16 - 20	2.0	1.5	±25

* The frequency tolerance limits in the table also apply for low and high power supply voltages of 26 and 30 volts dc, respectively.

51. Harmonic and Spurious Frequencies Test

The harmonic and spurious frequencies higher than 25 megacycles become too weak to measure. This test measures them up to 25 megacycles only. Make the test with the equipment located in a screen room to prevent the pick-up of frequencies not generated in Radio Transmitter Modulator MD–203/GR.

a. Series Resistor. A 100,000-ohm series resistor is used to reduce the signal input to the calibrated receiver. The series resistor should be in a metal shield and have male and female BNC-type connectors for ease of connection in the circuit.

b. Connections. Connect the equipment as shown in figure 30. Use a T-connector at the MO INPUT receptacle of the modulator to provide a connection for reading the input voltage applied to the MO INPUT receptacle. Connect the signal generator to the T-connector. Connect the modulator to a 27.5-volt dc power source. Use a T-connector at the FSK OUTPUT receptacle and make a connection to the FSK IN receptacle of a Radio Transmitter T–195/GRC–19 which has the internal cable connections made for fsk operation. The 100,000-ohm series resistor and the 51-ohm impedance-matching network, which is an accessory of the Field Strength Meter AN/PRM–1A, are connected in the cabling to the ANT receptacle of the field strength meter.

c. Test Procedure.

(1) Turn the equipment on and allow at least a 10-minute warmup period at 27.5 volts dc.

(2) Turn the MCS BAND SELECTOR

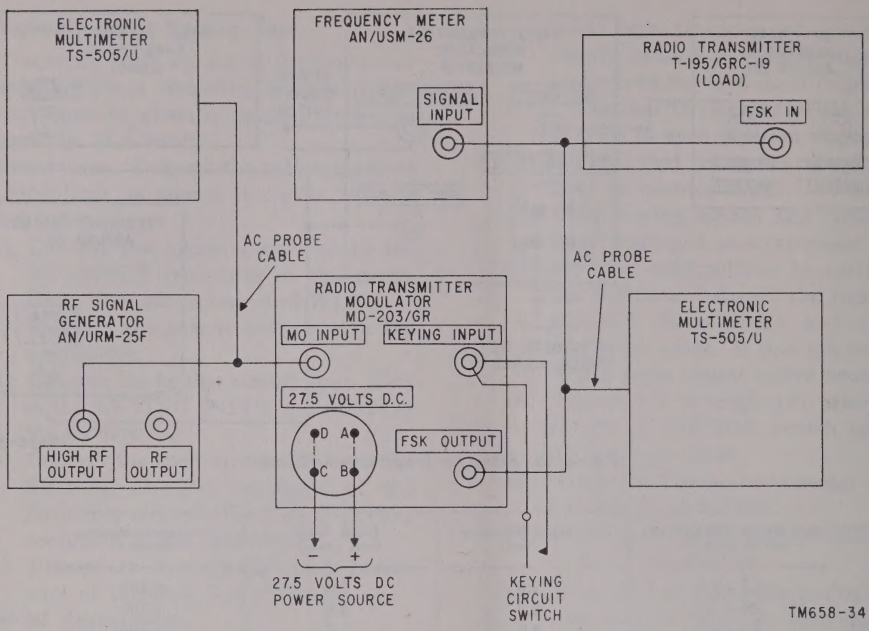


Figure 29. Setup for frequency tolerance test.

switch on the modulator to the 1.5-1.7 position.

(3) Set the signal generator frequency at 1.5 megacycles and the signal generator output level at 1.93 volts ac for the first test, as shown in the 1.5 megacycles column in the chart in (14) below.

(4) Calibrate the field strength meter according to the calibration charts provided with the field strength meter before taking readings.

(5) Tune the field strength meter to the 1.5 megacycles frequency (fundamental), and obtain the db reading or level indication. Record the reading for the fundamental for the first test.

(6) Remove the cable from the FSK OUTPUT of the modulator and connect the cable directly to the HIGH RF OUTPUT of the signal generator (RF OUTPUT for lower voltages).

(7) Tune the frequency of the signal generator to the frequency at which the field strength meter is set.

(8) Adjust the output voltage of the signal generator until the level indication is the same as in (5) above. Record the input signal voltage to the field strength meter.

(9) Search the spectrum with each signal generator test frequency (input to the modulator), from 150 kilocycles to 25 megacycles, for spurious and harmonic signals (with the field strength meter). Set the signal generator and MCS BAND SELECTOR switch as shown in the chart in (14) below.

(10) At each signal frequency detected, repeat (5) through (8) above.

(11) Calculate the difference in db between the voltage found at each spurious or harmonic frequency and the voltage measured at the fundamental frequency.

(12) The db difference must not be less

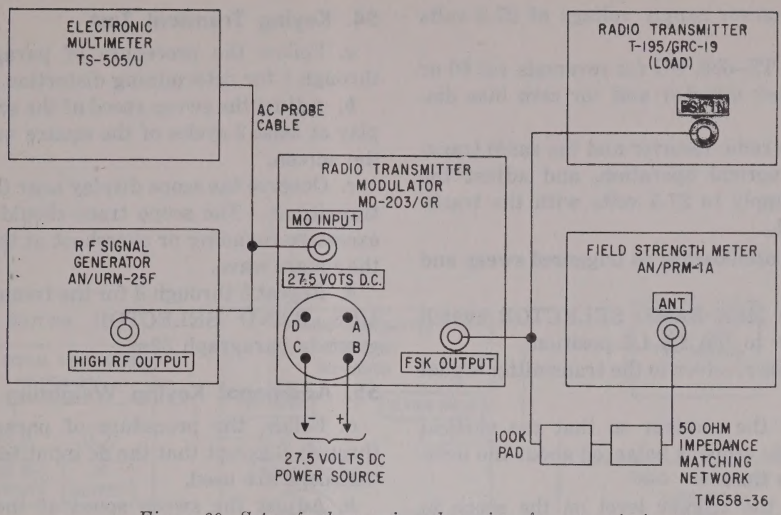


Figure 30. Setup for harmonic and spurious frequency test.

than the –db value given in the chart in (14) below.

(13) Spurious responses must be at least 50 db below the fundamental signal level.

(14) The readings for the fundamental and related frequencies of each position of the MCS BAND SELECTOR switch are as follows:

MCS BAND SELECTOR switch position	1.5-1.7	3-4	9-12	16-20
Signal generator frequency (mc)	1.5	2	2.5	3
Signal generator output level (v ac)	1.93	1.53	1.25	1.01
Fundamental (uv)	3,500	4,000 uv	4,000	2,500
2d harmonic (uv)	375	230	300	130
3d harmonic (uv)	350	220	200	65
4th harmonic (uv)	75	80	75	50
5th harmonic (uv)	50	75	50	25
6th harmonic (uv)	Less than 50	Less than 50	0	0
Spurious (uv)	Less than 50	0	0	0

Note. Readings given may vary ±75 microvolts for the larger values.

52. Keying Weighting Test

a. Connect the equipment as shown in the diagram (fig. 31).

b. Turn the POWER switch to ON and let the equipment warm up for 10 minutes, with the normal power supply voltage of 27.5 volts dc.

c. Set the TS–383/GG for "reversals" and adjust the oscilloscope to obtain pulses equally above and below the horizontal center line (use dc input terminals of the scope).

d. Set the TS–383/GG for "blank" teletypewriter code, and then for "letters" teletypewriter code. Under both conditions, the trace on the osciloscope should maintain the same horizontal position.

53. Teletypewriter Bias Distortion

a. Connect the equipment as shown in the diagram (fig. 32).

b. Turn the POWER switch to ON and let the equipment warm up for 10 minutes, with

the normal power supply voltage of 27.5 volts dc.

c. Set the TS–659/UG for reversals (at 60 or 100 words per minute) and for zero bias distortion.

d. Set the radio receiver and the radio transmitter for normal operation, and adjust the dc power supply to 27.5 volts with the transmitter keyed.

e. Set the oscilloscope on triggered sweep and dc input.

f. Set the MCS BAND SELECTOR switch (modulator) to the 1.5-1.7 position.

g. Tune the receiver to the transmitter signal frequency.

h. Adjust the receiver so that the vertical display on the scope is balanced about the horizontal center line.

i. Adjust the trigger level on the scope to begin sweep on the positive edge of the input voltage.

j. Adjust the sweep speed on the scope to display 1 cycle of the square wave across exactly eight divisions of the screen.

k. Observe the number of divisions and fractions between the two consecutive transitions of the square wave voltage.

l. The distance between the transitions should not be less than 3.8 nor more than 4.2 divisions.

m. Repeat *a* through *l* above with the MCS BAND SELECTOR switch in the 1.5-1.7, 9-12, and 16-20 positions, and the frequencies at 3.5, 12, and 20 mcs, respectively.

54. Keying Transient Test

a. Follow the procedure of paragraph 53*a* through *j* for determining distortion.

b. Adjust the sweep speed of the scope to display at least 2 cycles of the square wave across the screen.

c. Observe the scope display near the vertical transitions. The scope trace should not show excessive rounding or overshoot at the edges of the square wave.

d. Repeat *b* through *d* for the frequencies and MCS BAND SELECTOR switch positions given in paragraph 53*m*.

55. Additional Keying Weighting Test

a. Follow the procedure of paragraph 53*a* through *j*, except that the dc input terminals of the scope are used.

b. Adjust the sweep speed of the scope to display more than 10 cycles of the square wave.

c. Adjust the amplitude and position of the vertical display so that the envelope of the trace extends exactly two major divisions above and below the horizontal center line of the screen.

d. Set Test Set TS–383/GG to deliver the teletypewriter code character for *letters*.

e. The envelope of the display must not have changed by more than plus or minus one-fifth of a major division from its position in *c* above.

f. Set Test Set TS–383/GG to deliver the teletypewriter code character representing "blank." Check for the same limits.

g. Repeat *b* through *f* above for the frequencies shown in paragraph 53*m*.

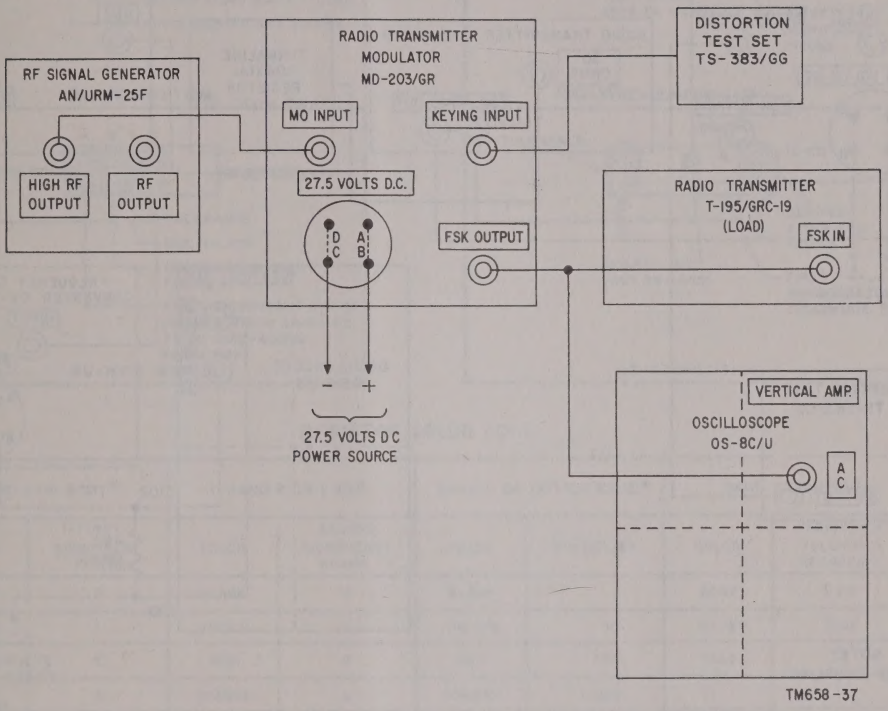


Figure 31. Setup for keying weighting test.

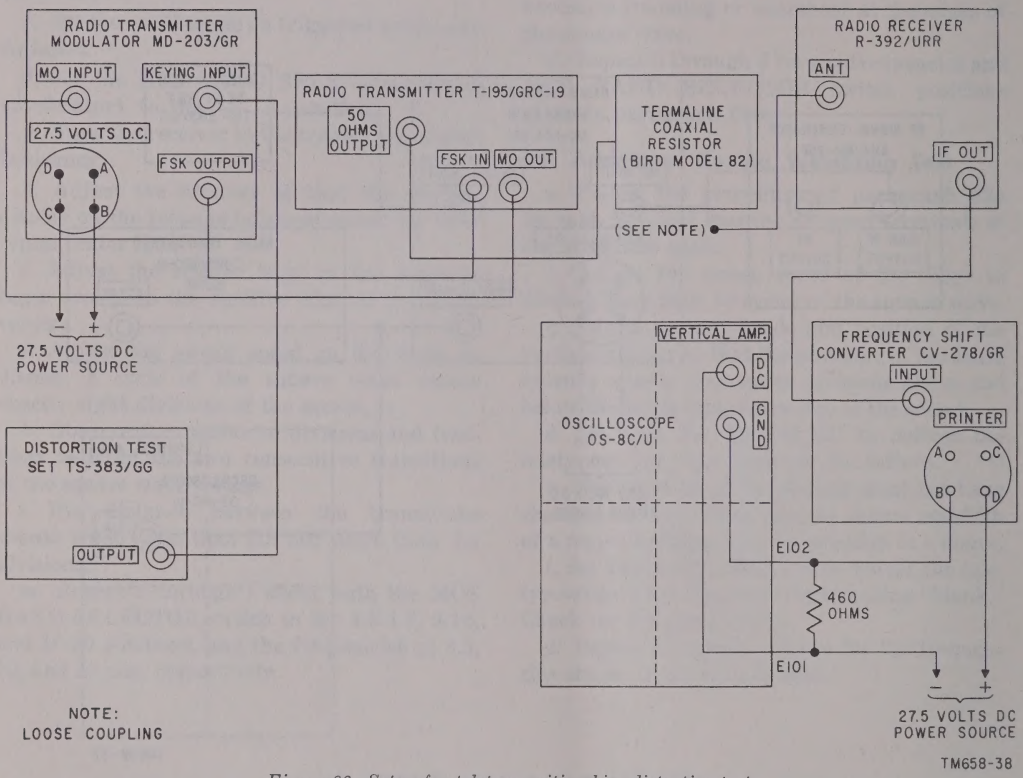
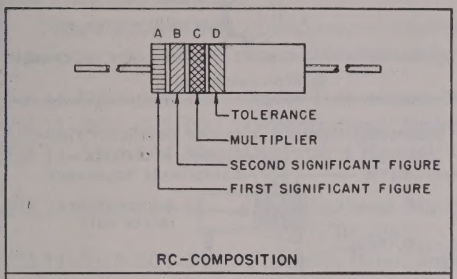


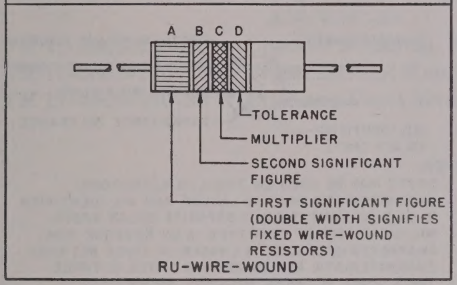
Figure 32. Setup for teletypewriting bias distortion test.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)

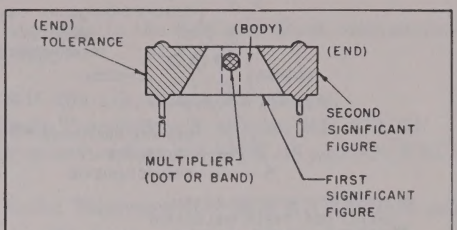


RC-COMPOSITION

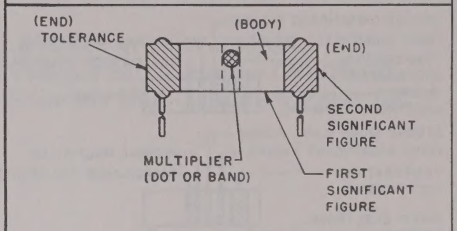


RU-WIRE-WOUND

RADIAL-LEAD RESISTORS (UNINSULATED)



RZ-COMPOSITION



RZ-COMPOSITION

RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

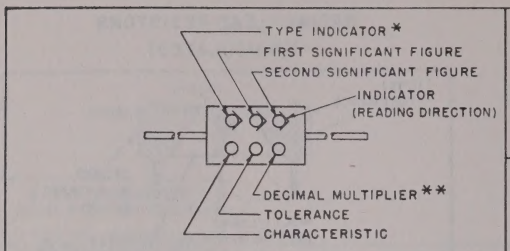
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY, BLACK END; RED DOT OR BAND; SILVER END.

STD-R1

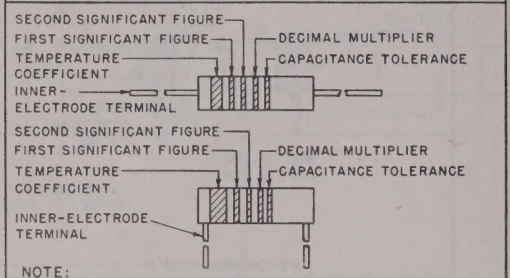
Figure 33. MIL-STD resistor color code markings.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



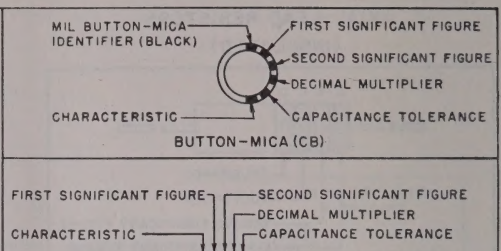
* BLACK DOT: MICA DIELECTRIC
SILVER DOT: PAPER DIELECTRIC
** INDICATES NUMBER OF ZEROS ON PAPER TYPE.

MICA (CM) AND PAPER (CN)

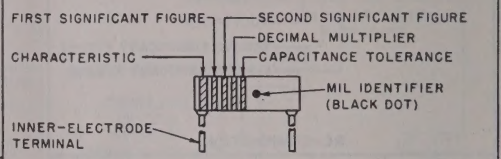


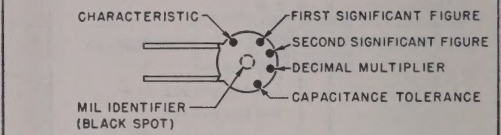
NOTE:
SPOTS MAY BE USED INSTEAD OF BANDS; TEMPERATURE COEFFICIENT MARKING IS LARGER.

CERAMIC-TEMPERATURE COMPENSATING (CC)



BUTTON-MICA (CB)





NOTES:
1. SPOTS MAY BE USED ON TUBULAR CAPACITORS; CHARACTERISTIC SPOT IS LARGER AND MIL IDENTIFIER IS ON SIDE DIAMETRICALLY OPPOSITE COLOR SPOTS.
2. MIL IDENTIFIER OF DISK TYPE IS ON REVERSE SIDE; CHARACTERISTIC SPOT IS LARGER OR SPACE BETWEEN CHARACTERISTIC AND TOLERANCE SPOTS IS THREE TIMES SPACE BETWEEN ADJACENT SPOTS.
3. TOLERANCE: YELLOW, +100%, -20%.

CERAMIC-GENERAL PURPOSE (CK)

CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE[2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500)[3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-CI

Figure 34. MIL-STD capacitor color code markings.

APPENDIX

REFERENCES

Following is a list of references applicable and available to the field and depot maintenance repairman of Radio Transmitter Modulator MD–203/GR.

TM 11–5820–205–10	Radio Transmitter Modulator MD–203/GR, Operator's Manual.
TM 11–5820–205–20	Organizational Maintenance, Radio Transmitter Modulator MD–203/GR.
TM 11–5815–204–10	Operator's Manual, Radio Teletypewriter Sets AN/GRC–46 and AN/VRC–29.
TM 11–5815–204–20	Organizational Maintenance, Radio Teletypewriter Sets AN/GRC–46 and AN/VRC–29.
TM 11–5815–204–35	Field and Depot Maintenance, Radio Teletypewriter Sets AN/GRC–46 and AN/VRC–29.
TM 11–5805–210–10	Operator's Manual, Frequency Shift Converter CV–278/GR.
TM 11–5805–210–20	Organizational Maintenance, Frequency Shift Converter CV–278/GR.
TM 11–5805–210–35	Field and Depot Maintenance, Frequency Shift Converter CV–278/GR.

	Paragraph	Page
Additional keying weighting test	55	48
Alinement:		
Frequency-shift circuit adjustment	42	38
Mixer and amplifier plate tuning	40	37
Oscillator plate tuning	39	36
Output level adjustment	41	37
Second oscillator frequency adjustment	43	40
Test equipment and special tools required for alinement	38	35
Band-pass filter FL103	8	9
Block diagram	3	2
Checking filament and B+ circuits for shorts	22	19
Checking voltages at tubes	29	29
Current drain check	47	42
Dc resistance of transformers and coils	28	28
First:		
Crystal controlled oscillator V102	6	6
Mixer V101	5	6
Wide-band amplifier V106	13	13
Fourth wide-band amplifier V108B	16	15
Frequency shift:		
Keyer circuit	7	7
Circuit adjustment	42	38
Keying test	49	44
Frequency tolerance test	50	44
General:		
Instructions	19	18
Parts replacement techniques	30	32
Harmonic and spurious frequency test	51	44
Input filter circuit	4	4
Isolating trouble within a stage	27	28
Keying, tests:		
Transient	54	48
Weighting	52	47
Localizing troubles	24	21
Low-pass filter FL102	12	13
Mixer and amplifier plate tuning, Z101 and Z103	40	37
Organization of troubleshooting procedures	20	18
Oscillator plate tuning, Z102 and Z104	39	36
Output level:		
Adjustment, C101 and C102	41	37
Test	48	42
Power application	18	16
Purpose of final testing	44	42
Removal:		
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Band-pass filter FL103	37	35
Dual low-pass filter FL101	35	35
Front panel	31	32
Low-pass filter FL102	36	35
MCS BAND SELECTOR switch	34	33
Oscillator-mixer subchassis	32	33
Replacement of MCS BAND SELECTOR switch	34	33
RF amplifier V103	9	11
Second:		
Crystal-controlled oscillator V104	11	12
Mixer V105	10	12
Oscillator frequency adjustment	43	40
Wide-band amplifier V107	14	14
Signal substitution	25	22
Special tools, and test equipment for alinement	38	35
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System applications	2	2
Teletypewriter bias distortion	53	47
Test equipment required:		
Alinement	38	35
Final testing	45	42
Troubleshooting	21	19
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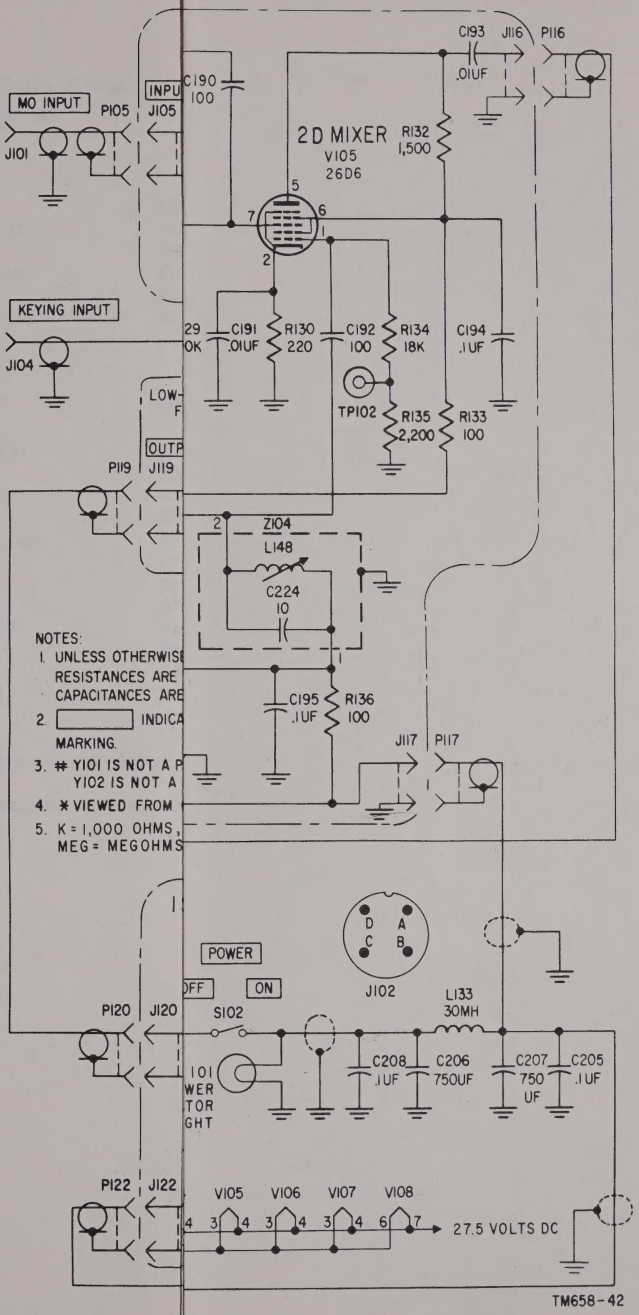
Additional keying weighting	55	48
Frequency shift keying	49	44
Frequency tolerance	50	44
Harmonic and spurious frequency	51	44
Keying:		
Transient	54	48
Weighting	52	47
Output level	48	42
Test setup:		
Final testing	46	42
Troubleshooting	23	20
Third wide-band amplifier V108A	15	14
Trap circuit Z105	17	15


MO INPUT
P105
J101
INPU
J105
C190
100
2D MIXER
V105
26D6
R132
1,500
C193
.01UF
J116
P116
KEYING INPUT
J104
29
0K
C191
.01UF
R130
220
C192
100
R134
18K
C194
.1UF
TP102
R135
2,200
R133
100
LOW-
F
OUTP
J119
P119
Z104
L148
C224
10
NOTES:
1. UNLESS OTHERWIS
RESISTANCES ARE
CAPACITANCES ARE
2.
INDICA
MARKING.
3. # Y101 IS NOT A P
Y102 IS NOT A
4. * VIEWED FROM
5. K = 1,000 OHMS,
MEG = MEGOHMS
C195
.1UF
R136
100
J117
P117
D
A
C
B
J102
POWER
OFF
ON
P120
J120
S102
L133
30MH
C208
.1UF
C206
750UF
C207
750
UF
C205
.1UF
101
WER
TOR
GHT
P122
J122
V105
V106
V107
V108
27.5 VOLTS DC
TM658-42

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Additional keying weighting test	55	48
Alinement:		
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Weighting	52	47
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Organization of troubleshooting procedures	20	18
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Dual low-pass filter FL101	35	35
Front panel	31	32
Low-pass filter FL102	36	35
MCS BAND SELECTOR switch	34	33
Oscillator-mixer subchassis	32	33
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Special tools, and test equipment for alinement	38	35
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System applications	2	2
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Troubleshooting	21	19
Tests:		
Additional keying weighting	55	48
Frequency shift keying	49	44
Frequency tolerance	50	44
Harmonic and spurious frequency	51	44
Keying:		
Transient	54	48
Weighting	52	47
Output level	48	42
Test setup:		
Final testing	46	42
Troubleshooting	23	20
Third wide-band amplifier V108A	15	14
Trap circuit Z105	17	15

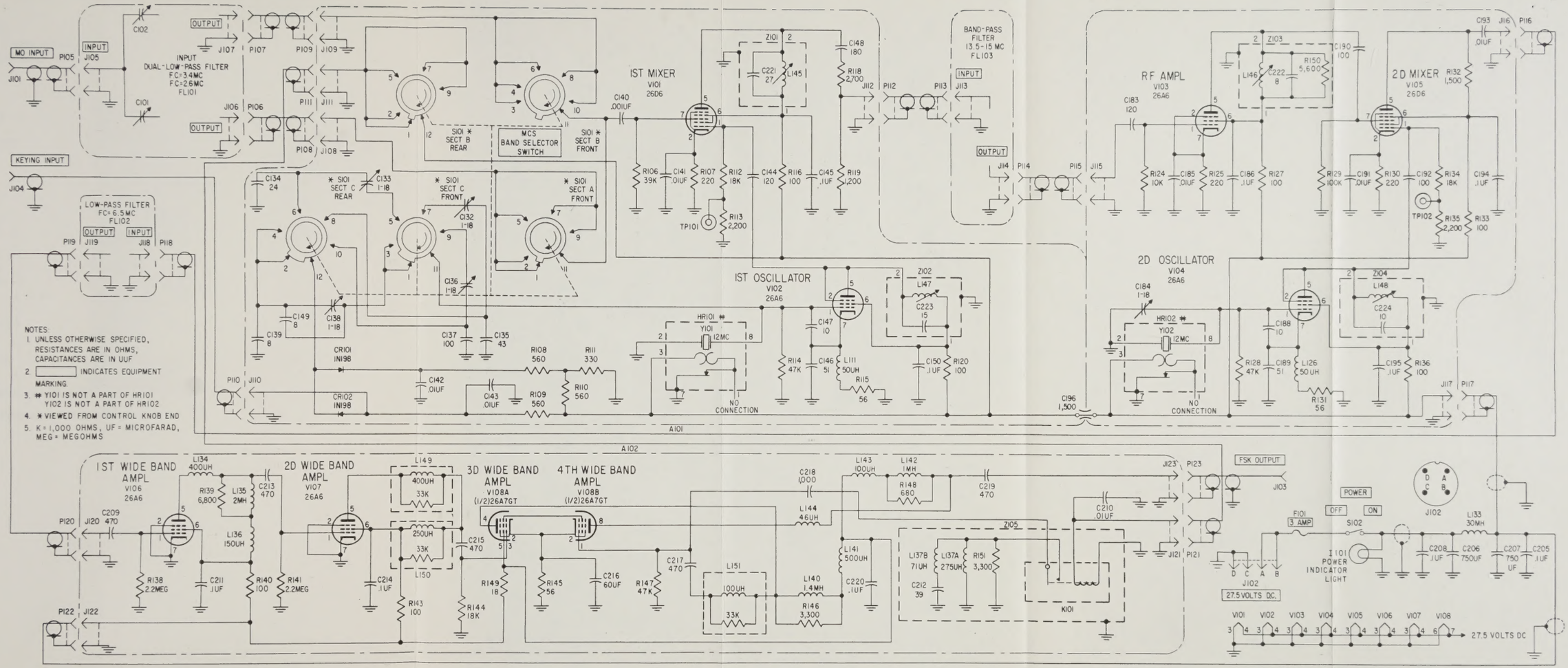
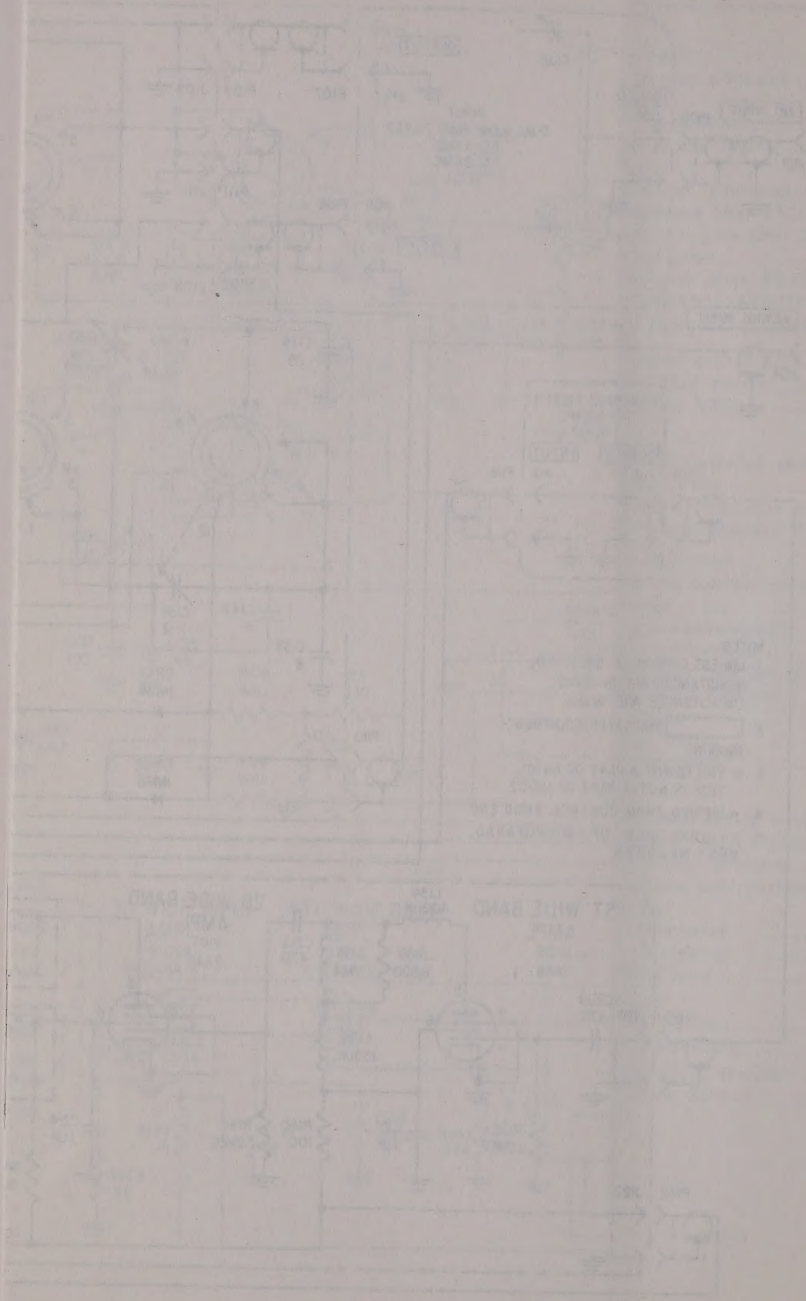


Figure 35. Radio Transmitter Modulator 203/GR, schematic diagram.



By Order of *Wilber M. Brucker*, Secretary of the Army:

L. L. LEMNITZER,
General, United States Army,
Chief of Staff.

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Major General, United States Army,
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Svc Colleges (5)
Br Svc Sch (5) except
USASCS (25) except
USASCS (Ft. Monmouth)
(27)
GENDEP (2) except
Atlanta GENDEP (none)
Sig Sec, GENDEP (10)
Sig Dep (17)
AFIP (1)
WRAMC (1)
Ports of Emb (OS) (2)
Trans Terminal Comd (1)
Army Terminals (1)
OS Sup Agcy (1)
Sig Fld Maint Shops (3)
Sig Lab (5)
AMS (1)
Engr Maint Cen (1)
Army Pictorial Cen (2)
USA Comm Agcy (2)
USA Sig Engr Agcy (1)
USA Sig Pub Agcy (8)
USA Sig Eqp Spt Agcy (2)
USA Sig Msl Spt Agcy (13)
USASSA (15)
USASSAMRO (1)
USA Corps (Res) (1)
JBUSMC (2)
Units org under fol TOE:
11–5 (2)
11–7 (2)
11–16 (2)
11–37 (2)
11–39 (2)
11–55 (2)
11–57 (2)
11–98 (2)
11–117 (2)
11–155 (2)
11–500 (AA–AE) (2)
11–555 (2)
11–557 (2)
11–587 (2)
11–592 (2)
11–597 (2)

NG: State AG (3); units—same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320–50.

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